

THE ARCHITECTURAL
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NO. 130.



Photo: Arch. Review Photo. Bureau.

THE UNITED KINGDOM PROVIDENT INSTITUTION, STRAND, LONDON.

DETAIL OF THE PRINCIPAL ENTRANCE.

HENRY T. HARE, ARCHITECT. (See p. 125.)

The figures over the entrance represent "Temperance" and "Prudence," and are the work of Mr. H. Poole. The grilles and sliding gates are of bronze, and the door is faced with bronze. The name-plates on either side of the entrance are of bronze, enriched with colour and gilding.

Report on
The Condition of St. Paul's Cathedral
by the
Committee Appointed by the Dean
and Chapter.

August, 1907.

TO THE VERY REVEREND THE DEAN AND TO THE CHAPTER OF
ST. PAUL'S CATHEDRAL.

GENTLEMEN,

In compliance with your instructions contained in a document, dated December 6th, 1906, appointing us a Committee to "examine and report upon

- "(1) The stability of the whole structure of the Cathedral;
- "(2) The extent to which the stability has been or is likely to be affected by any alterations or disturbances in the foundations of the Cathedral, or in the soil in its neighbourhood;
- "(3) The measures which ought to be taken to remedy such defects or guard against such dangers as may be discovered;"

we have now the honour to place before you the following report.

In the first instance we thought it expedient to address to you an interim report dealing with the question of the route of the London County Council sewer, which, as originally proposed, would have been within 45 ft. of the south-west tower of the Cathedral. We were gratified to learn that this report was adopted by you, and to find that the London County Council, after due consideration, had agreed upon another route. By this decision, we are of opinion that great danger to the Cathedral has been averted.

During the course of our inquiries we have had access to various documents containing much matter of interest of which we have been glad to avail ourselves. We gather from these and from

other sources that the nature of the subsoil, on which the present Cathedral is built, was from the first a matter of the gravest concern, and that Sir Christopher Wren was much impressed by the seriousness of the problem of obtaining suitable foundations for his church.

Wren could never have had any thought of preserving and making use of the old foundations. The alteration of the axis of the Cathedral and the departure from the mediæval plan necessarily meant entirely new foundations.¹ He expressly states that "he feared the old and new would not stand together without cracks." His first care, therefore, was to ascertain exactly the nature of the subsoil, which he proceeded to do in a very practical and exhaustive manner.

He sank wells at different points about the site to test the soil.² In this way he found the hard pot-earth "to be on the north side of the churchyard about 6 ft. thick and more, but thinner and thinner toward the south until upon the declining of the hill scarce 4 ft.³ Still he searched lower, and found nothing but dry sand mixed sometimes unequally but loose, so that it would run through the fingers." He went on till he came to water and sand, mixed with what he took to be sea shells, but which later expert opinion has pronounced to be fresh-water univalves. Below this he came to "hard beach," and under that to the natural hard clay which lies under "the city and country and Thames also far and wide."

Wren found that the flow of water through the gravel stratum tended towards the river,⁴ and that probably there had been no divergence or

¹ See Appendix I.

² "Parentalia," p. 285.

³ A comparison of these figures with those of Appendix II. will show a considerable difference in the layer of pot-earth at the present time.

⁴ According to our observations, the trend of the water is more in the direction of Ludgate Hill.

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interruption of this flow for centuries, and it was certainly reasonable to suppose that these conditions would be maintained. History shows, however, that these anticipations were not fulfilled.

These researches led Wren to the conclusion that the subsoil which had been sufficient to support the old church might very well be sufficient to support the new one. The alternative was to pierce the six feet of pot-earth and carry down his foundations through the loose gravel and water on to the blue clay; this would have meant a depth of foundations about thirty-seven feet below the level of the street.

We quote the following from "Parentalia" as to the foundations for the new fabric, which were begun in 1674.

"He began laying the foundation from the west end, and had proceeded successfully through the Dome to the East end. But at the North-east corner he came upon a pit whence all the pot earth was gone . . . Rejecting the proposal to pile, he dug down to the hard beach above the London clay, and on it built a solid pier of masonry 16 ft. square, carrying this up to within 15 ft. of the ground where he turned an arch to join the other foundations." It is, perhaps, noteworthy that this north-east corner of the north aisle of the crypt is at present slightly the highest point in the crypt floor: this indicates that the compression on the two natures of subsoil was unequal.

In the carrying out of the work "the greatest care and industry was used, so that by the beginning of April anno 1685 the walls of the quire with the side isles thereto containing one hundred and seventy feet and in breadth one hundred twenty foot, with the great arched vaults underneath, were finished. As also two stately porticoes North and South opposite to each other and the huge and massive pillars of the Dome (which is one hundred and eight foot in diameter within the walls) brought to the same height, the work being totally wrought of large Portland stone."⁵

The west end of the old church was not entirely taken down until 1686.

Contracts for timber for covering the aisles of the new choir were signed in June 1688, but it was not until December 2nd, 1697, that the choir was formally dedicated, the occasion being the thanksgiving for the Peace of Ryswick. The morning-prayer chapel, the present St. Dunstan's chapel, was completed in 1698-9, which would seem to imply that the work at the west end was then nearly finished. The topmost stone of the dome was laid in 1710, the date usually taken as marking the completion of the building, though

much work was still going on within and without, and much was left undone.

But before this date, in December 1709, an entry in the Cathedral pay-book records "work done in repairing flaws occasioned by ye pressure, making good such stones as could be left remaining with lead and plaister being the eight Leggs of the Dome and in the inside of the East, W., N., and South cross being above 1,500 foot in periphery." This repairing continues in the two months following. Similar entries are found during the first six months of 1716, where one of the legs of the dome is mentioned as having been repaired with "42 tun of Portland stone," and again in 1722, when repairs to the south-east leg of the Dome are specified. One of Wren's original drawings in the Cathedral Library is a quarter plan of the dome area on which the great south-east pier is noted as "the peer which has been repaired,"⁶ and the work was done by Edward Strong, who succeeded his father and uncle as Clerk of Works. From Clutterbuck's "History of Hertfordshire" we learn of Edward Strong that he "also repaired all the blemishes and fractures in the several legs and arches of the Dome, occasioned by the great weight of the said Dome pressing upon the foundations; the earth under the same being of an unequal temper, the loamy part thereof gave more way to the great weights than that which was gravel, so that the south-west quarter of the Dome and the six smaller legs of the other quarter of the Dome, having less superficies, sunk into the thinner part of the loamy ground, an inch in some places, in others two inches, and in other places something more; and the other quarters of the Dome being on the thicker part of the loamy ground and gravel, it did not give so much way to the great weight as the other did, which occasioned the fractures and blemishes in the several arches and legs of the Dome."

From these extracts it will be seen that before the completion of the building a settlement of the dome piers, especially those on the south side, had begun, the extent and direction of which may be seen in the diagrams and plans specially prepared for our report, and from the reports of the former Surveyor of the Fabric, Mr. Somers Clarke. From his annual report, dated October 1902, we quote the following:—

"That which to the eye of the spectator below looks like a colonnade surrounding the drum of the dome, is in fact a series of buttresses radiating from the centre of the circle, and resisting the thrusts of the dome and the cone. The outer ends of the buttresses are fashioned to resemble columns.

⁵ Ellis's Edition of Dugdale, page 140.

⁶ See Appendix III.

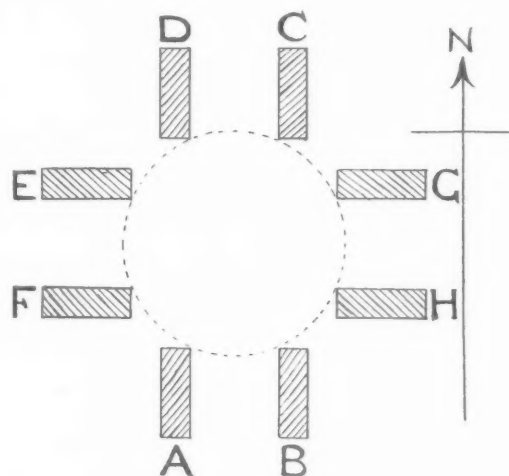
Each buttress is pierced by an arched opening, and over this is an eye or round hole pierced through the buttress.

"The settlement that occurred long since, by which the mass of the dome has sunk vertically some $4\frac{1}{2}$ in. downward, has cracked through all these buttresses, some more, some less. The drum of the dome in descending has left the colonnade behind. . . .

THE ENDS OF THE NORTH AND SOUTH TRANSEPTS.

"Very considerable movements have taken place in the end walls of these transepts. The south transept has suffered most, and I will first call attention to it. As has been stated in previous reports, the sinking of the piers on which rests the vast mass of the dome has completely cracked through the arches, window heads, and generally the whole of the walls of the east and west sides of the transept.⁷

"How great some of the dislocation has been will be well understood on examining the diagram with the figures I subjoin.



The pier A has descended bodily $6\frac{1}{8}$ in.

"	"	B	"	"	"	$4\frac{5}{8}$ in.
"	"	C	"	"	"	$3\frac{1}{4}$ in.
"	"	D	"	"	"	$3\frac{5}{8}$ in.
"	"	E	"	"	"	$3\frac{3}{8}$ in.
"	"	F	"	"	"	$2\frac{1}{6}$ in.
"	"	G	"	"	"	$2\frac{5}{16}$ in.
"	"	H	"	"	"	$2\frac{5}{16}$ in.

"These levels are taken on the Cornice or balcony which runs round the interior of the building. The level of the cornice at A on the Dome pier is $6\frac{1}{8}$ in. lower than it is across the South end of the South Transept. Between the South or end wall of the South Transept and the pier which carries the Dome at A, the great arch into the aisle, and the

clerestory wall above are broken through. In a less degree, according to the subsidence of the mass of the dome, this occurs in connection with each Dome pier.

"Very strong horizontal iron ties were put in about 100 years since at the level of the internal cornice or balcony, but the results of the dislocation are still seen, inasmuch as the arches of the clerestory windows are so broken as to be in parts resting on the vertical iron stanchions which should only support the glazing, and should not in any way be forced against the arch. . . ."

The photographs⁸ show some of the cracks to which Mr. Clarke drew attention, and in proof of the early origin of the trouble, we may give a single illustration from the building itself. The clerestory windows nearest to the dome, those of choir and nave as well as those of the quarter domes, are much distorted. The sills all slope in the direction of the dome itself, and have been levelled up. Above these windows the whole wall has followed the same inclination, and just below the cornice wedge-shaped courses of stone have been inserted, the flat ends towards the dome and the thin ends east and west, &c., to enable the cornice to run through. These wedge-shaped pieces may be seen on the north, as well as on the south side of the church. From this it is evident that a settlement was early at work, in spite of Wren's plans for spreading the enormous weight of the dome over as wide an area as possible; the repairs are recorded, and before the height of the cornice was reached a space of several inches had to be made up to the level.

Early in the nineteenth century the City of London was engaged in enlarging or building new sewers, and one of them was put down on the south side of the church. This probably had the effect of disturbing the even flow of water. There were also other causes which may have conduced to a similar effect, and to which we refer later on.

Apart from the settlements which, we think, occurred in the early eighteenth century, there have been three sources whence the ground on which the Cathedral is built has most probably been affected. St. Paul's stands on a hill, and since the Cathedral was built this hill has been gradually covered in, by buildings and paved roads, yards, and footways. A roof has thus been placed over the whole area by which the drainage of the surface water has been affected, and for some time past this surface water has been unable to percolate freely as it did in the seventeenth and eighteenth centuries.

Next, the various alterations along the riverside more immediately south and west of the Cathedral,

⁷ See Appendix IV.

⁸ See Appendix IV.

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have affected the flow of water in the lower strata above the London clay.

Thirdly, the ground all round the Cathedral has been subjected to sundry borings for sewers and the like, as well as for excavating the deep basements of the surrounding warehouses, while the pumping operations at Blackfriars in connection with the Underground Railway have probably drawn the water from the site.

We may here quote two instances of proposed underground workings close to the Cathedral in the last century, which were diverted owing to the representations of the Cathedral's guardians.

In 1831, a sewer was proposed along the south side of the churchyard, a course similar, though at a higher level, to that of the London County Council sewer which has just been abandoned. Mr. Cockerell, the Surveyor to the Dean and Chapter, investigated the proposal with Messrs. George Rennie, the engineer, and Robert Smirke, the architect, and together they issued the following report:—

"We, the undersigned, having by direction of the Dean and Chapter of St. Paul's Cathedral examined and considered the situation in which the Commissioners of Sewers have begun to construct a Sewer on the South side of the Cathedral, and considering that the footings of the walls rest chiefly upon a thin bed of pot-earth, beneath which is a very deep stratum of sand and gravel, containing a considerable quantity of water, and that the walls of the South Transept have sunk and are fractured, apparently by reason of some partial weakness in this part of the foundations, are of opinion that the security of the Fabric will be endangered if the Sewer is constructed in the Church Yard.

"We are likewise of opinion that however carefully the work may be constructed, it will be impossible to prevent some degree of motion from taking place in the side stratum of sand and gravel either during the construction of the sewer or at a future period in consequence of it; and we therefore earnestly recommend that the Commissioners should be requested to abandon this line for their sewage, and remove it to such a distance as will prevent all risk of injury to the perfect security of the Cathedral."

Owing to this report the sewer, which was to have run under the road of the Churchyard, was diverted along Carter Lane.

Writing in 1874, Mr. Longman, the author of "The Three Cathedrals of St. Paul's," says: "Wren's belief in the solidity of the ground for the foundations of the Cathedral has been fully justified by time, but yet there is danger still lurking in the bed of sand which might become serious. If this bed of sand were pierced by a

drain, there would be a great probability of its running off and leaving the pot-earth insufficiently supported."

The question of the Cathedral's safety was again raised on the promotion of the Central London Railway Bill in 1890. Referring to this in his report to the Dean and Chapter in November of that year, Mr. Penrose, the Surveyor to the Fabric, said as follows: "As there is great probability that a tunnel so placed (*i.e.*, at a depth of more than 70 ft. below the floor of the Church) would drain off water from the lower strata of the gravel and sand which underlie the foundations of the Cathedral and so cause them to some extent to collapse, there would be great risk of serious injury to the structure. This scheme passed a Committee of the House of Commons, but was thrown out by the Committee of the other House, not indeed without cost to the Dean and Chapter, but it appears to be a great danger averted."

In his evidence supporting the petition lodged by the Dean and Chapter against the Bill, Mr. Penrose said: "The danger to the structure of St. Paul's Cathedral if the proposed works are carried out exists chiefly on account of the sandy nature of the strata upon which the foundations stand. These foundations are laid upon a comparatively thin bed of marl, below which there exists more than 40 ft. of loose sand and gravel. It must also be remembered that St. Paul's Cathedral is erected on the top of a considerable hill. If the water which is mixed with these strata was withdrawn, the result might, in my opinion, be exceedingly serious, as this must cause a very considerable collapse in the strata themselves. . . . In the excavations which must take place for the purpose of the proposed Railway Tunnel, and more especially in the large excavation which would be required for the intended station between Newgate Street and the Cathedral at the depth proposed, which is some 60 ft. below the present surface, there would be very great risk of interfering with these strata, and if this excavation should, as in all probability it must, take place irregularly over the section of the works within the immediate proximity of St. Paul's, the danger would be very considerably increased."

The following year, on November 10, 1891, in his Annual Report, Mr. Penrose reverts to the same subject: "Last year there had been the alarm of injury likely to arise to the foundations of the Cathedral from the Central London Railway. This apprehension of danger mainly arose from the proximity of the deep underground station, for which a large excavation is required. Since then the Bill has been reintroduced and sanctioned, but the danger to the Cathedral is very greatly reduced owing to the removal of the

Report on the Condition of St. Paul's Cathedral. III

Station to a greater distance. There may indeed still be some risk arising from the tube which is to enclose the railway, though to a much smaller extent; still, enough remains to make it of consequence that very great care should be taken that no operations connected with the alterations which I have heard are proposed to be made to some of the Pillars of the Choir,⁹ should be carried out in a manner to weaken those supports, and particularly so as there is a want of uniformity in the foundations of the Choir."

We learn further that the Dome and the West Towers were plumbed by the former Surveyor to the Fabric in August 1901, and the results were as follows: The Dome, in a drop of three hundred and thirty feet to the nave floor, was found to incline four and three-quarter inches towards the south-west. The South-West Tower was plumbed from a height of one hundred and thirteen feet, and in this distance the deviation was six inches.

We have no information as to whether the movements in the fabric continued uninterruptedly or not, but we have gathered from various documents, and from the reports made by former Cathedral Surveyors, that the settlements of the fabric which occurred during the building of the Church, and particularly in the piers supporting the dome, have continued in some degree to the present day.

After the weight of the main building had compressed the subsoil to its limit we think it may be assumed that there was a period of quiescence, but that during and subsequent to the erection of the Dome movements began to show themselves as a result of the additional weight.

In order to ascertain the various strata and the exact water level beneath the Church, we have thought it well to make experimental borings at three different points in the crypt, and kept samples of the strata, one set of which has been accepted for the Geological Museum. These were made in March last, and their progress carefully watched. The results disclosed are embodied in the chart which accompanies our Report.¹⁰

At the same time we had the foundations uncovered at different points, and found the footings were formed of three twelve-inch courses of stone slabs with a projection of two feet, the level of the pot-earth being about four feet six inches below the crypt floor.

We have made a minute and personal examina-

tion of the structure generally, and especially of those parts which appeared to have suffered most by the settlements, and for this purpose five of our meetings have been held in the Cathedral. We have referred to the principal fractures in the building; there are others,¹¹ and notably that between the Library and the main building, which have had our careful attention. They appear to be of long standing, and we have no record of their origin, but at present they do not give ground for special anxiety. We have seen no evidence of "crushing" as a result of the various settlements.

After mature deliberation and a thorough examination of the Cathedral and its foundations we are of opinion that in spite of these settlements there is no immediate necessity for any extensive remedial measures to be undertaken; but this conclusion is based on the assumption that the present conditions of the subsoil and the present water level will be maintained. We are strongly of opinion that the sensitive condition of the structure makes it necessary that the Church should be kept under constant observation, and we understand that a scheme for this has been formulated by Messrs. Barry and Leslie, your Engineers. We recommend that your Surveyor be instructed to make the necessary arrangements for its adoption, and for readings to be taken every three months.

We also recommend that the condition of the subsoil and the state of the water level be carefully watched and periodically recorded, as all official investigations point to the same conclusion—that in them lie the possibilities of future dangers. In this connection attention should be given to all building operations in the neighbourhood, or mischief of a more serious nature may arise.

We may mention that we have carefully considered the various safeguards and remedies brought forward at our meetings and published by the press and others interested in the building, but we do not advise works of underpinning or of screening the foundations of the Church. We consider that such operations would only be attended by fresh dangers. On the other hand

⁹ Mr. Harding, Clerk of the Works at the Cathedral, states that when veneering the pilasters in the choir with marble, the stone, although of the best quality, splintered and flew in all directions when cut, thus showing the great compressive stress it was sustaining. The same thing occurred when recessing

panels in the spandrels of the quarter domes, though the cutting was only two and a half inches deep. In one instance a large piece of stone flew out in the absence of the workmen.

¹⁰ See Appendix II.

¹¹ See Appendices III. and V.

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we consider that there is a large amount of structural work required in repairing the fabric which should be proceeded with without delay.

The condition of the external stonework also calls for attention, and we have had the advantage of the opinion of Professor Church, who advises the removal of the incrustations of soot and gypsum by a wood tool, and the experimental spraying of portions of the surface with baryta.

The coffered vault of the west portico, we understand, had for some years shown signs of being to a certain extent crippled, which damage may have been caused by a slight movement to its abutments. This has now been rectified, and the structure, as reinstated, is in practically the same condition as it was left by Wren. Mr. W. D. Caröe, the Architect to the Ecclesiastical Commissioners, was kind enough to attend our last meeting in the Church, and agreed with what was being done.

The plaster of the walls of the crypt, which has been removed, should be reinstated throughout

the interior. It was evidently Wren's intention that the crypt walls, being composed of stones of varying quality, should be plastered, and the protection thus afforded is very valuable.

The heating apparatus is antiquated and should be abolished. At present the strong sulphur fumes from it undoubtedly have a deleterious effect on the stone. Your Surveyor should be instructed to devise an entirely new system of heating for the Church.

In conclusion we must pay a tribute to the wonderful constructive ability of Sir Christopher Wren. That a building of the magnitude and weight of St. Paul's should have survived the altered conditions of the subsoil without more serious damage is an evidence of his masterly skill and ingenuity, for he provided against every danger known to his time. Other dangers, however, have since arisen which he could not have foreseen, and now, being recognised, they must be met by unceasing vigilance and constant attention.

We are, Gentlemen,

Your obedient servants,

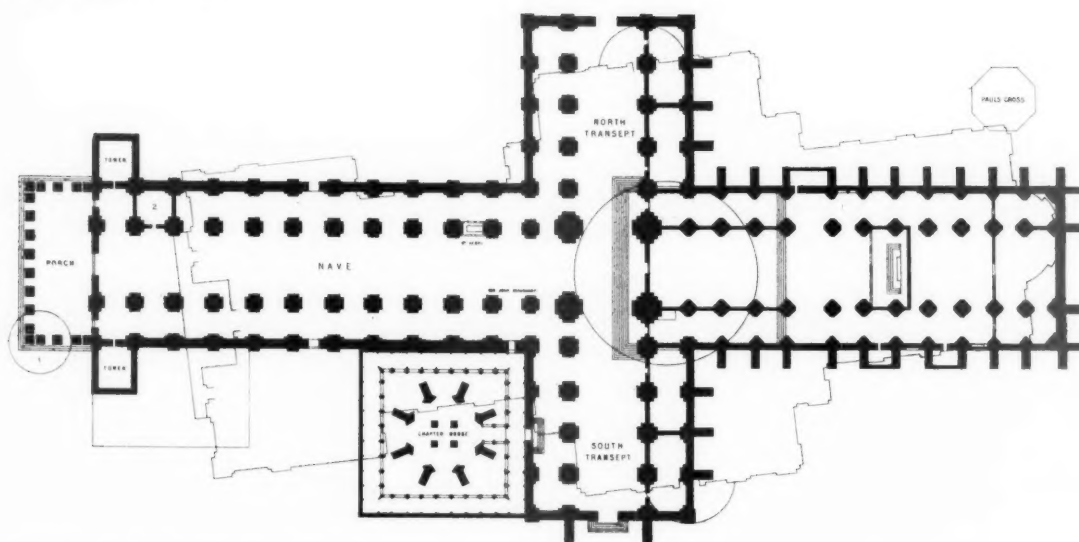
THOS. COLLCUTT, P.R.I.B.A.

ASTON WEBB.

JOHN BELCHER.

MERVYN MACARTNEY.

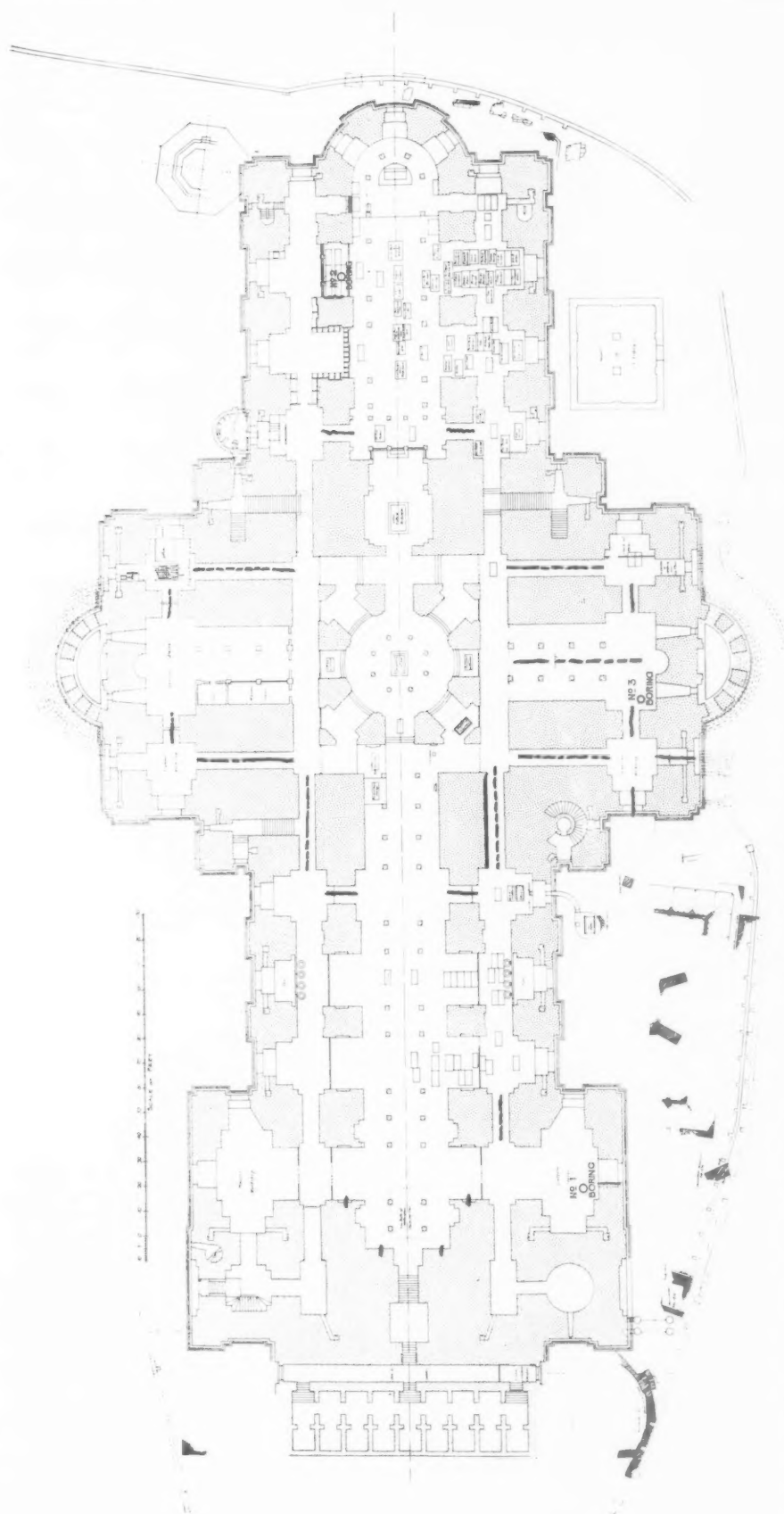
APPENDIX I (A).



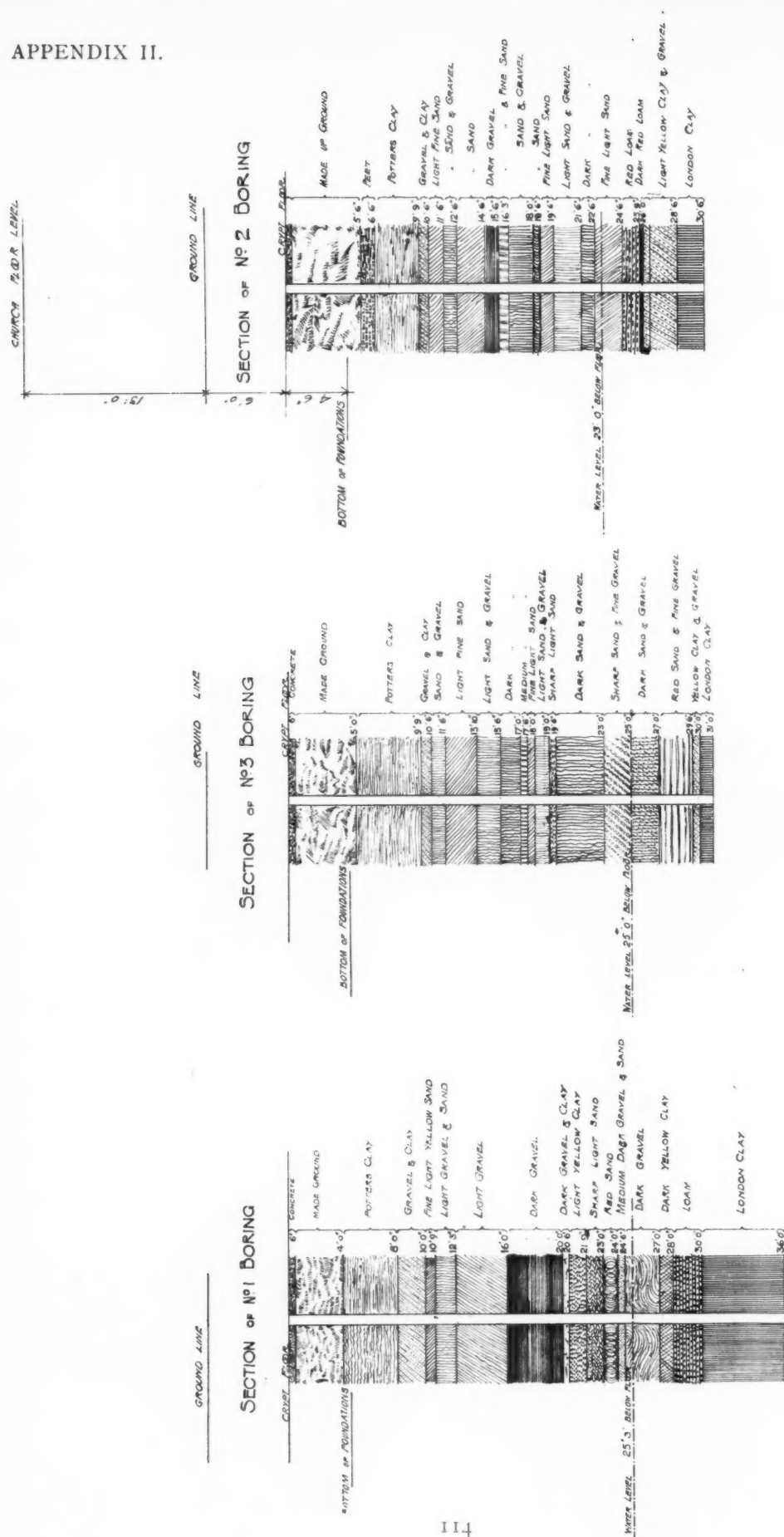
GROUND PLAN OF OLD ST. PAUL'S,

SHOWING IN OUTLINE THE CHANGE OF AXIS IN THE PRESENT CATHEDRAL.

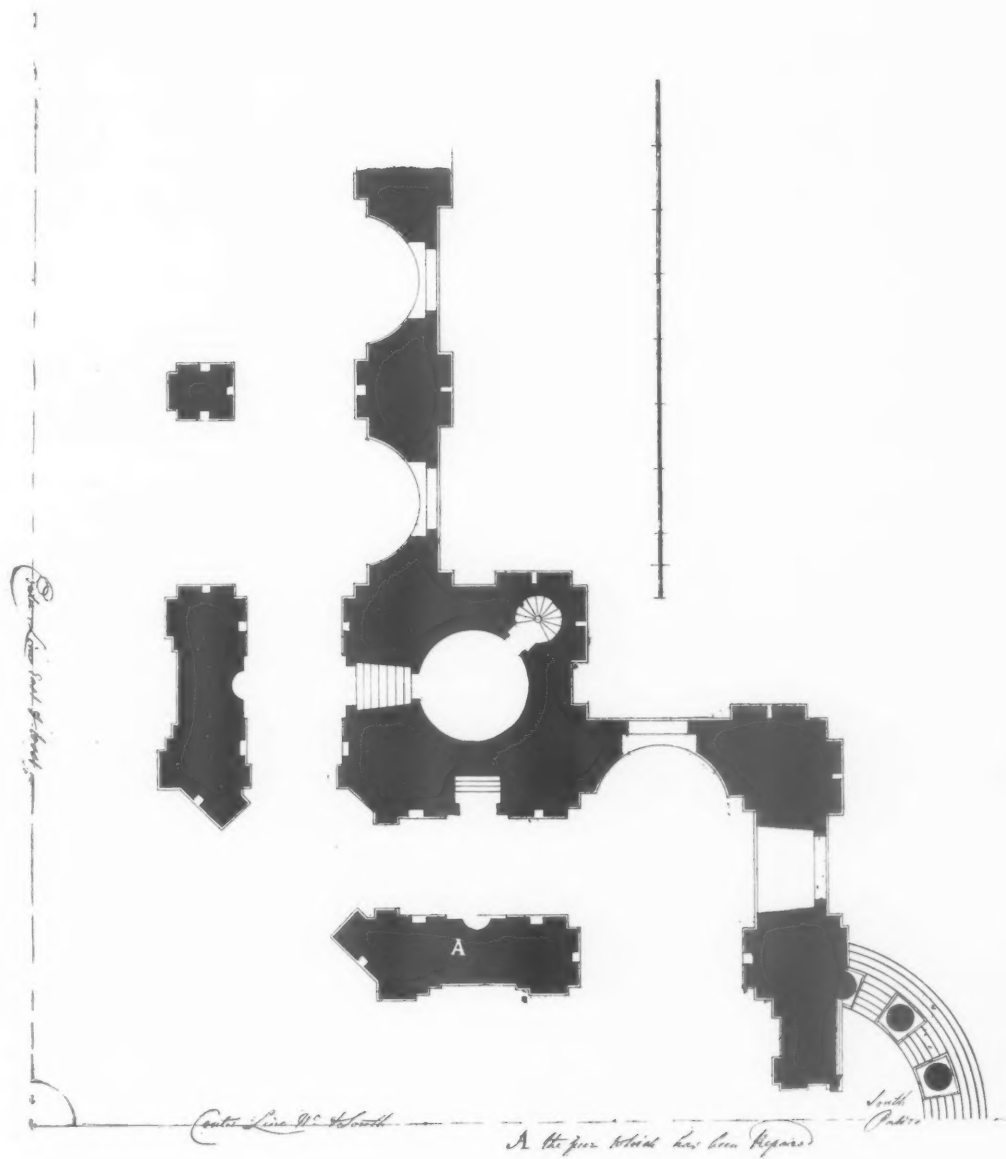
APPENDIX I (B).



PLAN OF THE CRYPT OF THE PRESENT CATHEDRAL, SHOWING POSITION OF CRACKS IN THE VAULTING AND ALSO THE POSITION OF THE BORINGS.

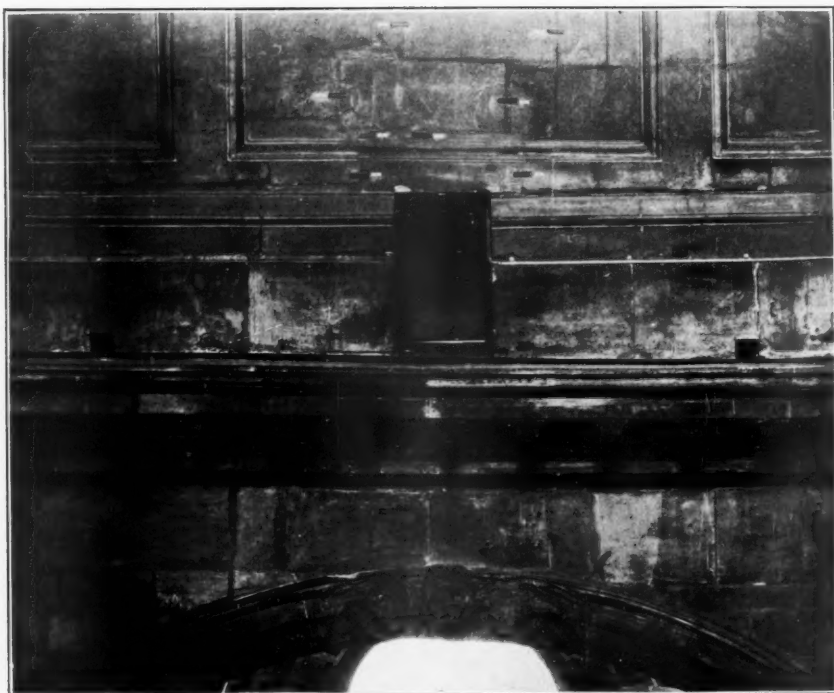


APPENDIX III.



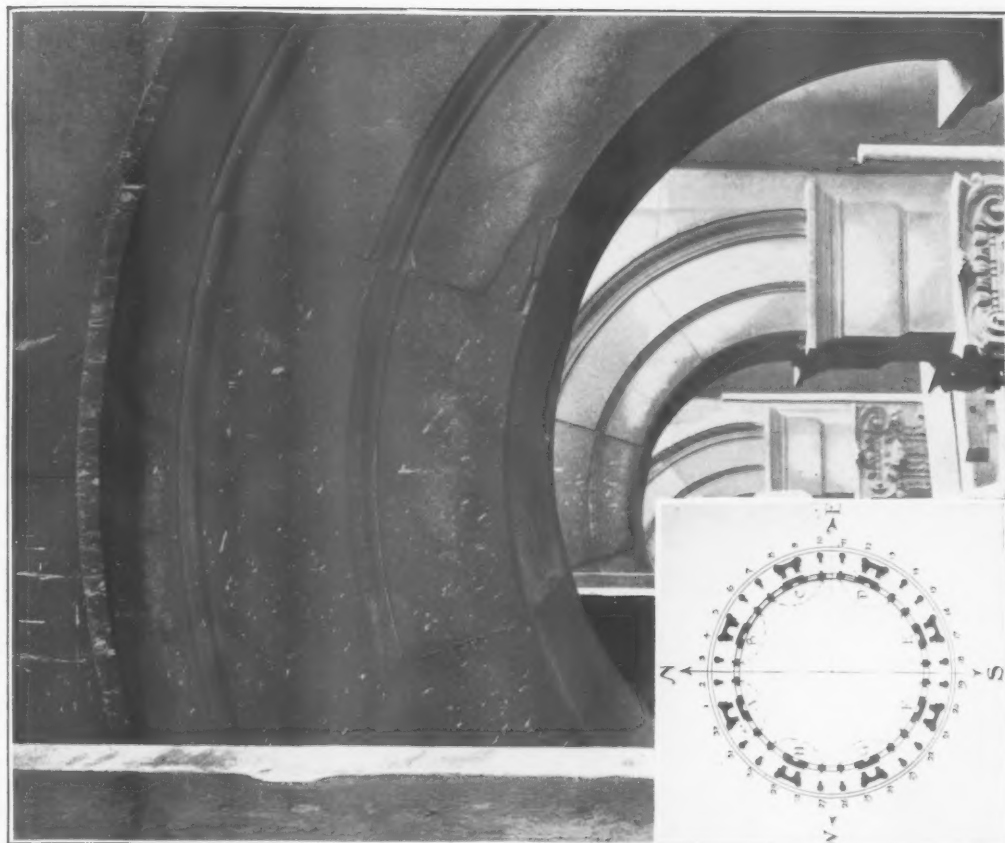
DRAWING OUT OF THE COLLECTION OF WREN DRAWINGS IN THE LIBRARY AT ST. PAUL'S,
SHOWING THE SOUTH-EAST "PEER WHICH HAS BEEN REPAIRED."

APPENDIX IV.

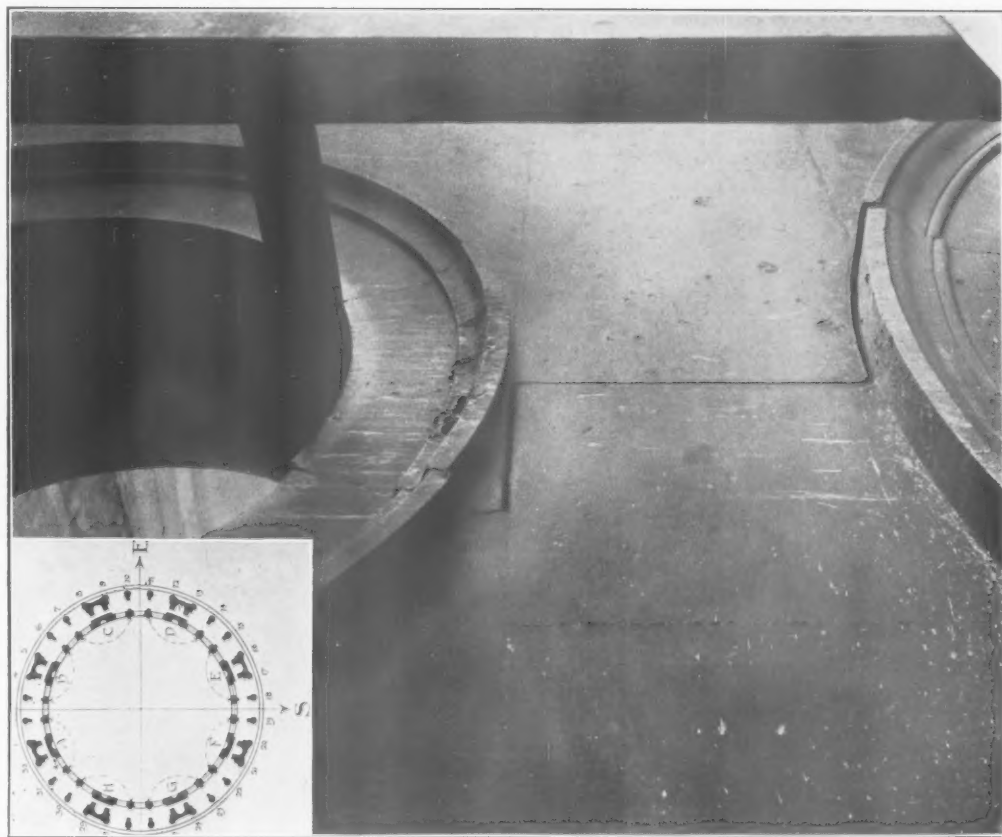


PHOTOGRAPHS SHOWING SINKING OF CORNICE AND CRACKS IN
EAST CLERESTORY WALL OF SOUTH TRANSEPT.

APPENDIX V

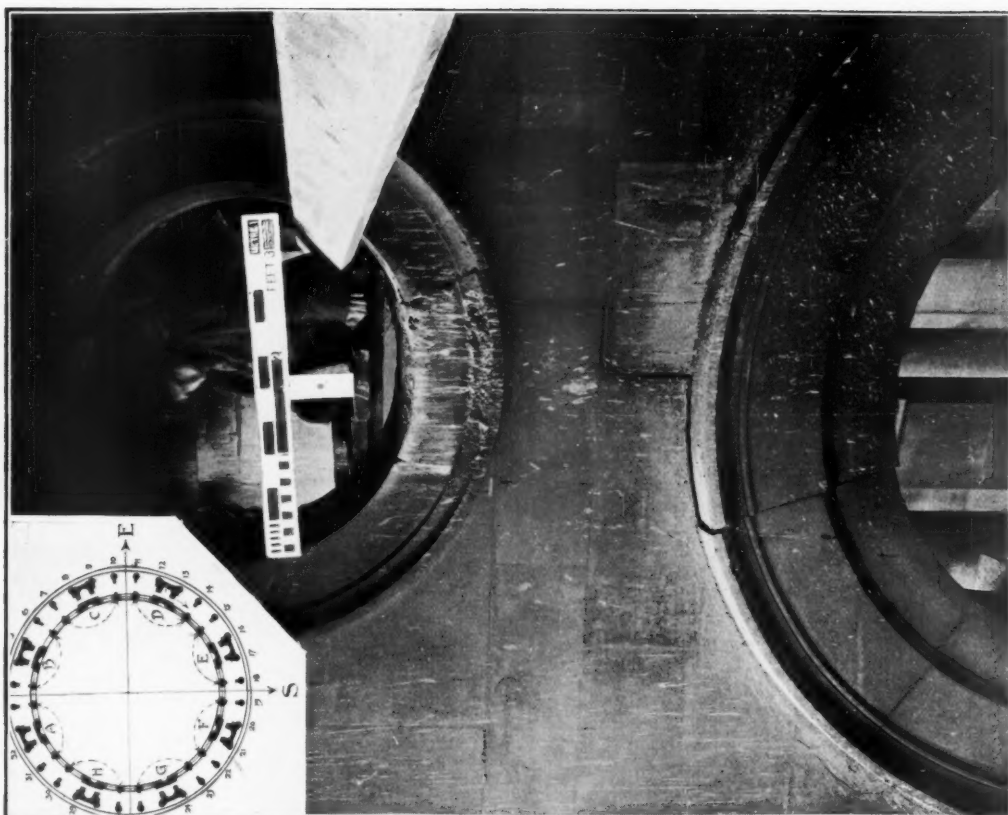


North-west Section : Arch 31. Position II.
Photographed November 1901.

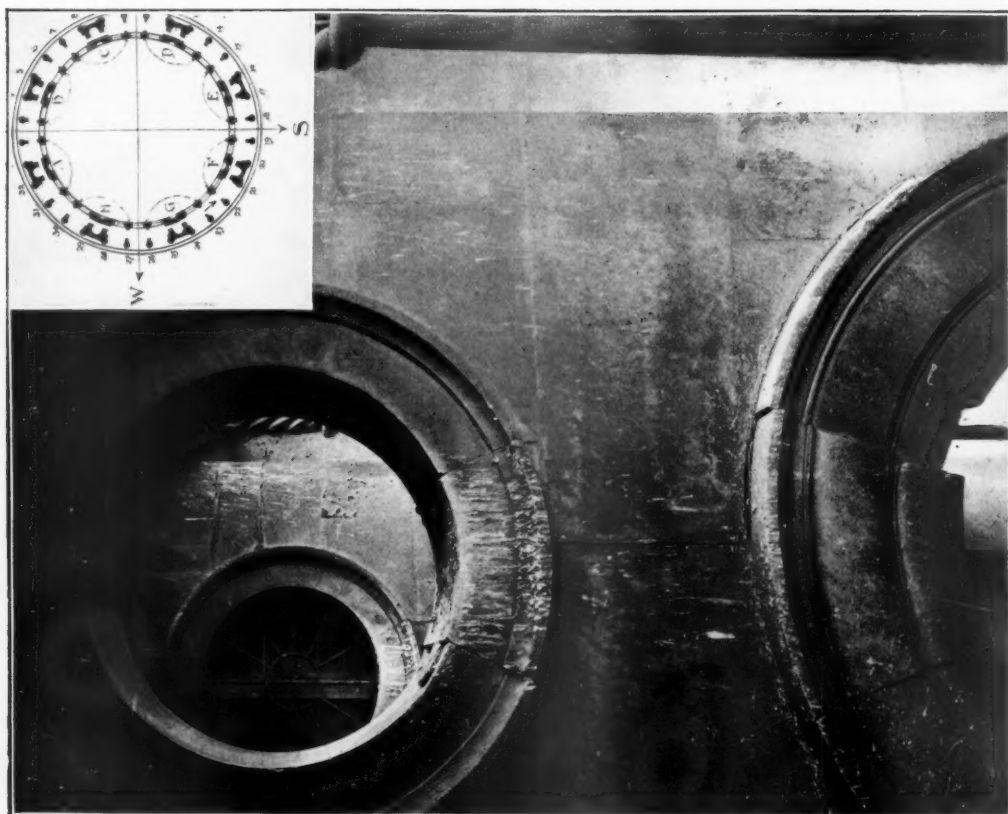


North-west Section : Arch 31. Position I.
Photographed November 1901.
CRACKS IN THE BUTRESSES OF THE DOME.

APPENDIX V.

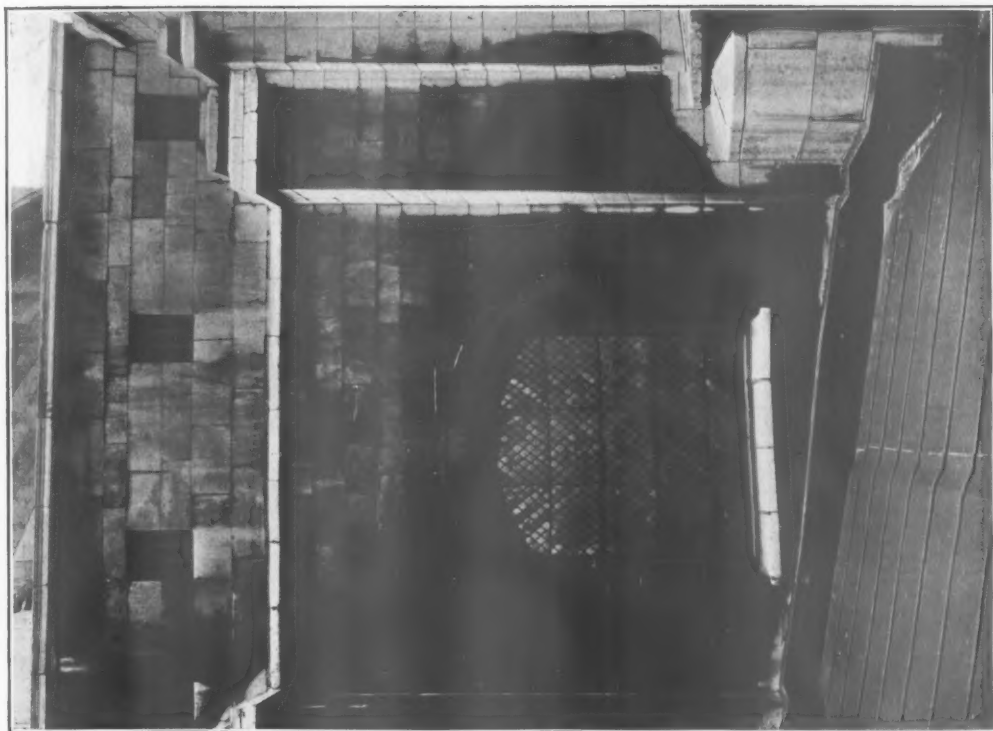


South-east Section : Arch No. 14 from Bull's-eye No. 13.
Photographed May 6th, 1902.

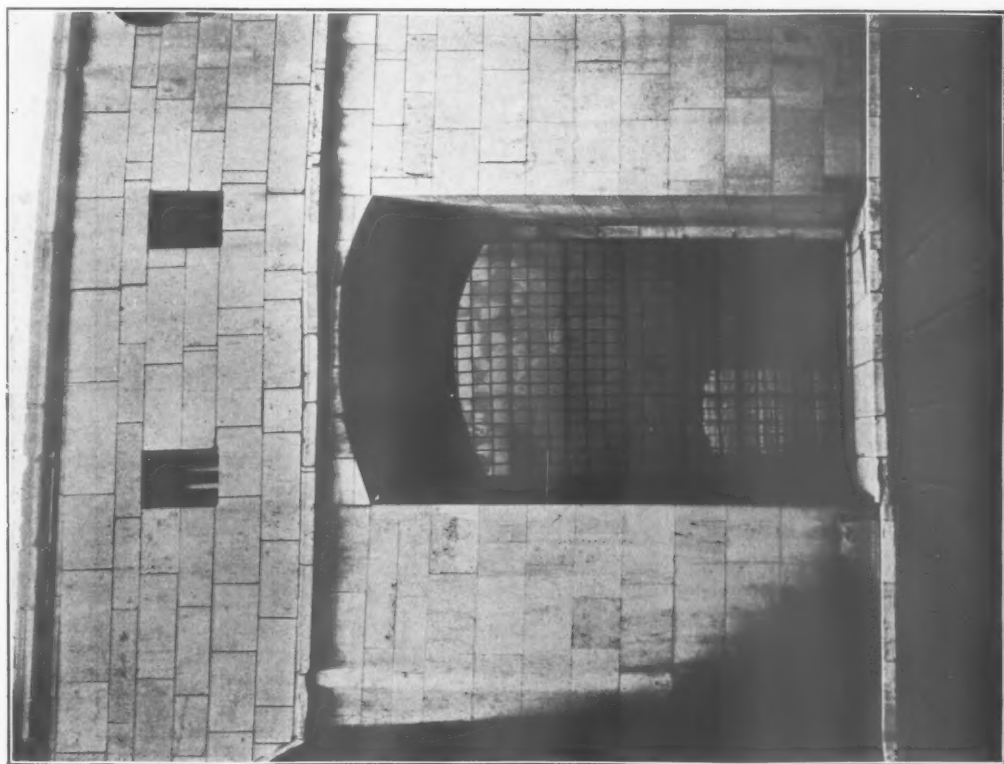


South-west Section : Arch No. 22 from Bull's-eye No. 23.
Photographed May 13th, 1902.
CRACKS IN THE BUTTRESSES OF THE DOME.

APPENDIX V.

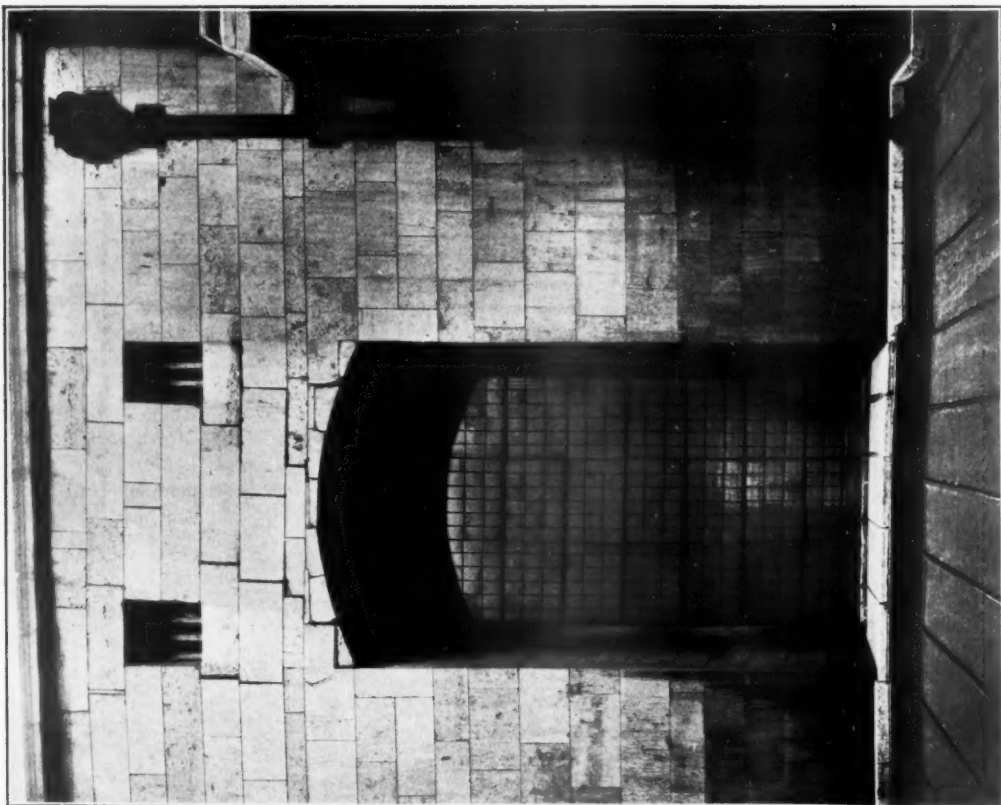


West Wall of South-west Quarter Dome from roof of South Aisle of Nave. June 1907.

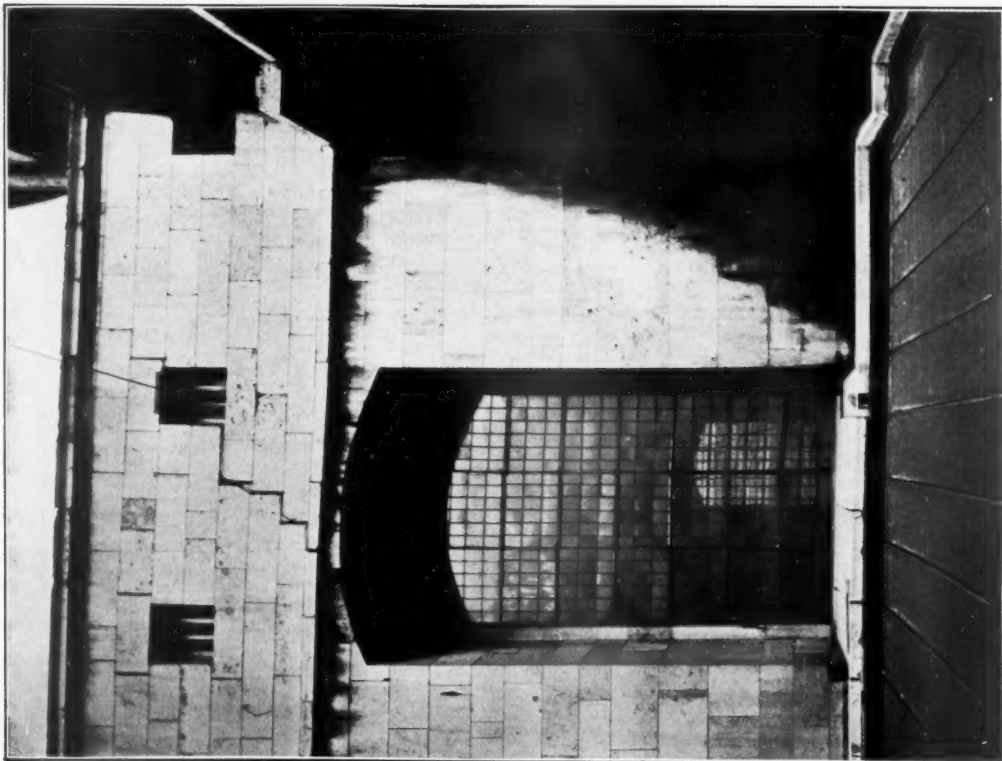


West Clerestory Wall of South Transept, from roof of West Aisle of South Transept. June 1907.
CRACKS AND SINKINGS IN EXTERIOR WALLS.

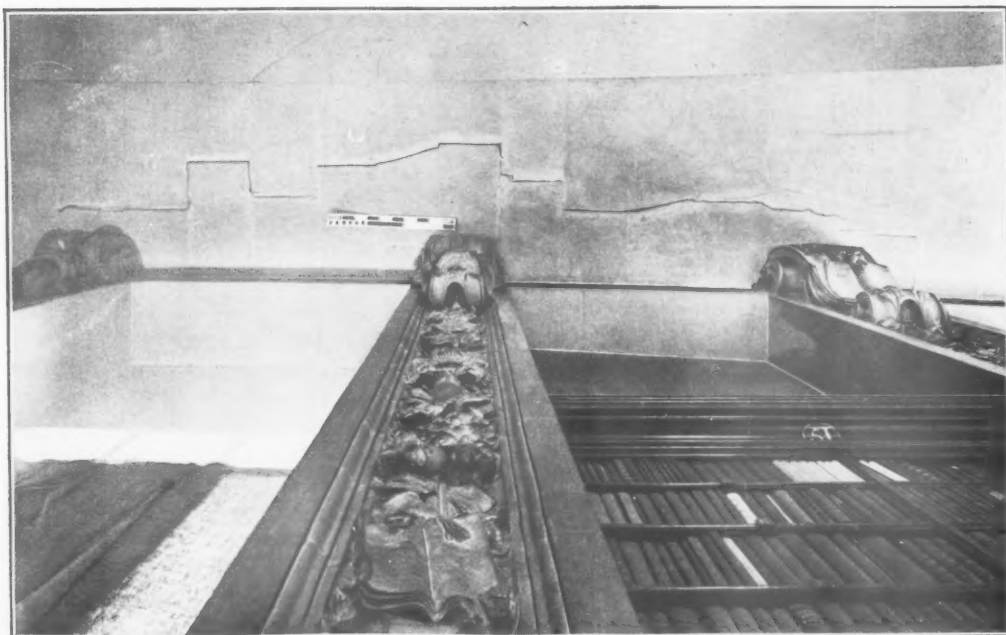
APPENDIX V.



East Clerestory Wall of South Transept, from roof of East Aisle of South Transept.
June 1907.



West Clerestory Wall of North Transept, from roof of West Aisle of North Transept.
June 1907.
CRACKS AND SINKINGS IN THE EXTERIOR TRANSEPT WALLS.

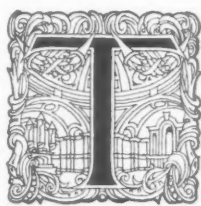


CRACK IN THE LIBRARY CEILING, LOOKING UPWARDS.

Photographed January 1902.

The United Kingdom Provident Institution.

Henry T. Hare, Architect.



HIS new building, which has been erected to provide offices suitable to the standing of the Institution, and to meet the needs of its increasing business, was opened in July by the Chancellor of the Exchequer. The site of the

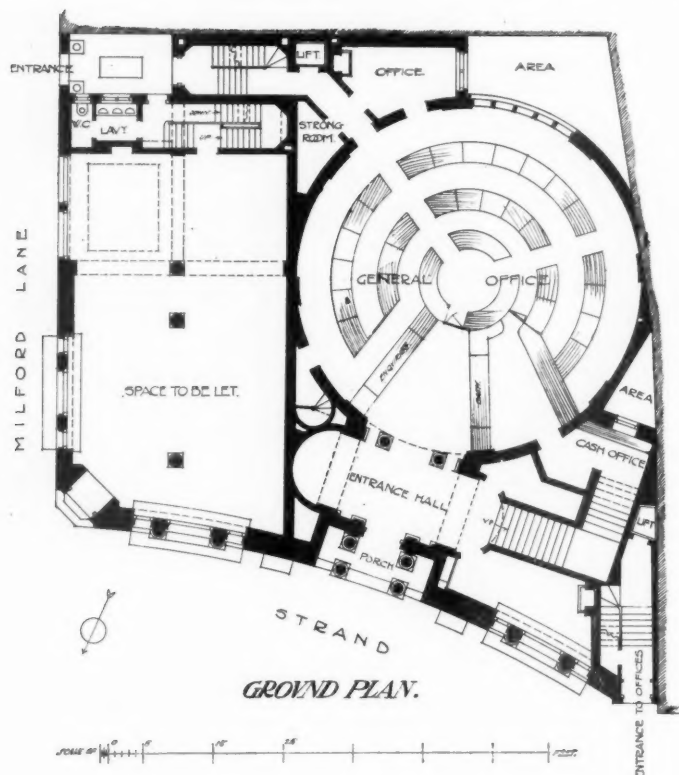
building is an important one, being opposite the church of St. Clement Danes, close to the Law Courts, and but a minute's walk from Temple Bar. The building not only provides for the Institution, but includes a considerable area available for letting.

The façade is of Portland stone on a base of grey-green granite. At the mezzanine floor level are three groups of figures by Henry Poole depicting (east to west) "Justice and Truth," "Temperance and Prudence," "Security and Industry." The same artist has also executed the group over the first-floor angle window representing "Prosperity," and the figures of "Watchfulness" and "Benignity" on the angle turret. The low-relief figures between the windows at the

second-floor level are the work of F. E. E. Schenck. There are ten in all, each figure being 7 ft. 6 in. in height, representing the virtues of "Faith," "Hope," "Wisdom," "Peace," "Temperance" (two), "Truth," "Justice," "Chastity," and "Industry."

The interior courts and light wells are lined with white glazed bricks, supplied by Allen & Son of Halifax.

The main entrance is in the centre of the frontage, and has a recessed porch which is enclosed, when the office is not open, by bronze sliding gates. The outer doors are also sheathed with bronze. Immediately inside is a spacious entrance-hall with a vaulted ceiling covered with vitreous mosaic, in the central compartment depicting the Signs of the Zodiac around a sun, being designed by J. Dudley Forsyth and executed, like all the other mosaic ceilings and wall linings, by Rust's Vitreous Mosaic Co., of London. On the tympanum facing the entrance is a decorative mosaic by Professor Moira representing "St. George and the Dragon." The walls here are lined with



marble, the monolith pilasters and columns being of selected Swiss Rubane cipollino, and the floor of Italian pavonazzo, verd antico, and Siberian green. The bronze lantern is the work of Baguès Frères, of London and Paris.

The general office opening out of the entrance-hall is a circular apartment, 50 ft. in diameter, covered by a flat dome, and lighted by a circular skylight, 18 ft. in diameter, the last-named

being the work of W. H. Heywood & Co., of London and Huddersfield. Like the entrance-hall, it is designed and decorated in the style of the First Empire, and by the same artists. It is lined entirely with marble and mosaic, a scheme of green, purple, and white, relieved with the mat gold and burnished glitter of the ormolu bronze parts. The eight green cipollino marble monolithic pilasters which divide this hall into bays are from a specially quarried block of exceptional width, and ribs of the same marble carry the line up to the central light in the dome, which is framed with a great bronze laurel-roll edged with cipollino marble. This roll is intersected at the junction with the ribs with cross ribbons, from which are suspended eight bronze electroliers. The wall linings in the bays are of violet and Greek cipollino, the former being a new variety of marble. A frieze, 5 ft. deep, runs around seven bays, the eighth being occupied by a large stained-glass window by J. Dudley Forsyth. The scheme of this window is governed

by the sculptured frieze which the five upper lights (of which details are given) intercept, the scheme of figures being carried through them. The golden bronze of the sculptured figures is in effect felt in the window, the subject of which is "Fructus Virtutis." In the five lower lights of the window enrichments in design of a more ornamental nature, embodying emblems and trophies, are carried out, and the whole is in



"Wisdom." "Hope."



"Chastity." "Industry."



"Truth." "Justice."

SIX OF THE FIGURES IN LOW RELIEF ON THE UPPER PART OF THE FAÇADE.

F. E. E. SCHENCK, SCULPTOR.



Photo: Arch. Review Photo Bureau.

GENERAL VIEW FROM THE EAST.

The sculptured figures on the angle turret represent "Watchfulness" and "Benignity"; that over the angle window on the first floor "Prosperity." They are the work of Mr. Henry Poole.



Photo: Arch. Review Photo. Bureau.

DETAIL OF EAST ANGLE OF FAÇADE.

The façades are in Portland stone. The sculptured figures over the first window are of "Justice" and "Truth," and are the work of Mr. Henry Poole. This corner part of the premises on the ground floor is available for letting. The door (not the principal entrance) is of mahogany, and the grilles and balcony railings are of bronze.



Photo : Arch. Review Photo. Bureau.

THE ENTRANCE-HALL FROM THE EAST, LOOKING TOWARDS THE MAIN STAIRCASE.

The style is that of the First Empire. The walls are lined with Swiss Rubane and Greek cipollino marbles, the capitals and bases of the columns, the skirtings, panels, and enrichments being of ormolu bronze designed by Mr. F. Lynn Jenkins. The mosaics on the vaulted ceiling were designed by Mr. J. Dudley Forsyth, that in the central vault depicting the Signs of the Zodiac. The marble floor is of Italian pavonazzo, verd antico, and Siberian green. On the tympanum over the entrance to the general office (on the left) is a mosaic representing St. George and the Dragon, by Professor Moira. A detail of this appears on another page.



Photo: Thomas Fall.

DETAIL OF UPPER PANELS OF STAINED-GLASS WINDOW IN THE GENERAL OFFICE.

BY J. DUDLEY FORSYTH.

character with the style adopted for the room. The frieze, the work of F. Lynn Jenkins, has a Penteli statuary marble background, on which are ormolu bronze figures in high relief. The motive of the frieze is "Life." Continuity of effect in the frieze is obtained by the large bronze panels on the pilasters at the same level, which act as grilles to the fresh-air inlets. These panels, the door architraves, radiator frames, skirtings, the bases and capitals of the columns, and decorative rolls, both here and in the entrance hall, were designed by Mr. Jenkins, and are of ormolu bronze richly chased. They have been very carefully worked in the style of the First Empire, and the Artist went to great trouble to obtain the exact colour of the lacquer in the best work of that period. The counter fittings and gate in ormolu bronze have been designed and executed by J. Starkie Gardner & Co., the same firm being responsible for most of the other bronze and metal work, &c. The counters have panels of very fine verd antico marble.

At the west end of the entrance-hall is the main staircase, lined entirely with marble, the panels being of Italian pavonazzo framed in Greek cipollino, the steps being of Piastraccia, and the landing pavements of the same marble with green Tinos introduced. The ceilings of the staircase are also lined with marble, antique Swiss cipollino and very light Skyros being the varieties employed. This and all the other marble work in the building was executed by H. T. Jenkins & Son, of Torquay.

The bronze enrichments, cornices, &c., on the main staircase were designed by F. Lynn Jenkins. The two stained-glass windows on this staircase are the work of J. Dudley Forsyth. The first, representing "Providence our Instructor," is shown in the view of the staircase; the second, "The Light of Truth," by a detail view.



Photo: Thomas Fall.

STAINED-GLASS WINDOW ON THE PRINCIPAL STAIRCASE, "THE LIGHT OF TRUTH."

BY J. DUDLEY FORSYTH.



VIEW OF THE GENERAL OFFICE FROM THE ENTRANCE-HALL.

Photo: Arch. Review Photo Bureau.

The style adopted for this and the entrance-hall is that of the First Empire. The wall space generally is divided up into eight bays, seven of which have a frieze, 5 ft. high, designed by Mr. F. Lynn Jenkins; the eighth bay is filled with a large stained-glass window by Mr. J. Dudley Forsyth. The colour scheme is cool grey green with purple and white, relieved with mat gold and bright ormolu bronze.

One of the most effective marble schemes is that of the Upper Hall leading to the Board-room, &c., where verd antico has been used for the mouldings, the wall-linings being of Irish green and antique Swiss cipollino. The large pilasters here are treated with inlays of the unique blue sodolite from the Princess Quarries

in Canada, so named after the Princess of Wales, who encouraged their development. The marble floor is of Italian pavonazzo, verd antico, and Siberian green. The ceiling, vaulted and treated with gold, is the work of F. E. E. Schenck. There are two windows, both of which are filled with stained glass by Professor Moira. The larger

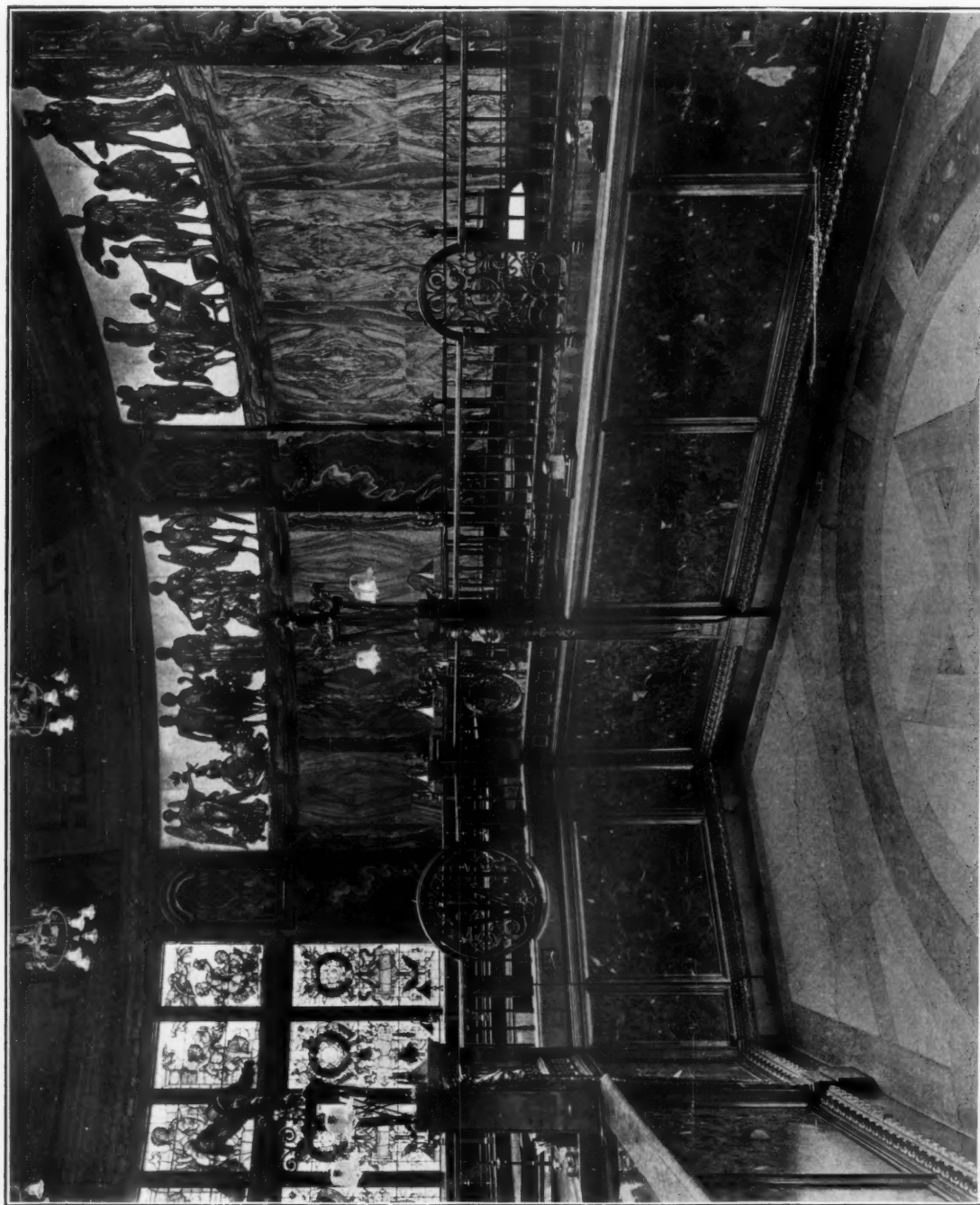


Photo: Arch. Review Photo. Bureau.

DETAIL OF THE COUNTER IN THE GENERAL OFFICE.

The first bay of the frieze seen in this view shows a winged figure "Immortality," followed by "Force," "Primitive Man and Woman," "Law," "Virtue repelling Vice," "Youthful Aspiration and Ambition." The second commences with the winged figure of Icarus, typifying "Youth," and there follow Psyche and Cupid, denoting the "Soul," and "Love," "Experience teaching Youth," "Sorrow" standing behind "Experience," "Man," the hunter or breadwinner, and "Motherhood"; while the remaining group of three figures in this panel denotes "The Promise of Success," "Health and Happiness," and "Plenty." The counter fittings are of ormolu bronze with bright and mat gold effects, and the panels in the counter are of fine quality verd antico marble.



DETAIL OF THE FRIEZE IN THE GENERAL OFFICE.

This was designed by Mr. F. Lynn Jenkins, the figures being of ormolu bronze on a background of Penteli statuary marble, the frieze being 5 ft. in height. This bay represents "Providence," and the paying in and withdrawal of savings.

Photo: Arch. Review Photo Bureau.



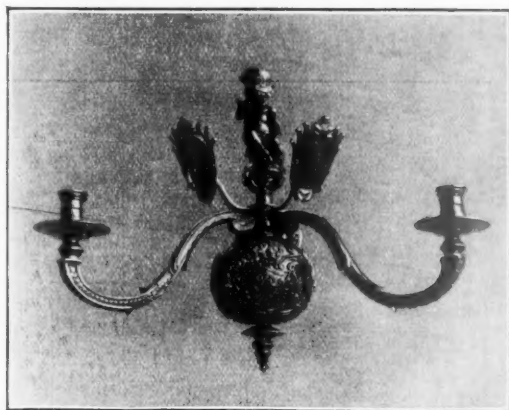
Photo: A. P. Monger.

CEILING-PAINTING IN THE BOARD-ROOM.¹

BY PROFESSOR MOIRA.

¹ The subject is an allegory symbolical of Providence protecting Childhood, Chastity, and the Fruits of Abundance from the Evil Powers.

In the central group a stately female figure, clad in a loose rich robe of gold, rests her right hand on the shoulders of a young girl, her left grasps the flowing ends of an ivory-coloured drapery, on which reposes the figure of a boy surrounded by various fruits; above this hangs the veil of obscurity, represented by a huge crimson curtain, surmounted by a reclining female figure with a branch of laurel in her hand representing Peace. The emblem of Hope is depicted by numbers of cupids who are endeavouring to hold up the curtain, which is in danger of being torn down by the machinations of the Evil Powers.



ELECTRIC-LIGHT BRACKET IN THE BOARD-ROOM.

one represents "Temperance," and the smaller contains a badge and motto. The doors opening on to this landing are of Spanish mahogany with finely figured panels. In the lunettes of the vaultings are three decorative panels in ormolu bronze and mother-of-pearl by Mr. Lynn Jenkins.

The principal room on the first floor is the Board-room, in Georgian style, with wainscot panelling having carved enrichments. This wood-work was executed by W. Aumonier & Son, London, who also executed the panelling in the adjoining managing director's room and the smaller rooms for the proposal clerk and the medical officer on the same floor. The ceiling-painting by Professor Moira is more particularly described under the detail illustration. It is surrounded by a frame of enriched plaster-work, this and the other enriched plaster-work being modelled by F. E. E. Schenck. The furniture, specially designed by the Architect, is executed in wainscot oak to harmonise with the panelling, the upholstery being carried out in a dull surface green leather, with carpets and curtains of similar green tint to match. The furniture and parquet flooring was executed by A. J. Arrowsmith & Co., of London. The electric-light pendants and brackets in this room were designed and executed by the Bromsgrove Guild of Applied Arts.

At either end of the room is a panel containing a portrait in oil, by Edwin A. Ward, of a former chairman of the Institution.

A golden rope sweeps from the curtain down to the right side of the composition, at which a man—Titian-like in colour—is pulling in a vain effort to frustrate the beneficent acts of Providence.

The Evil Powers, grouped at the west end of the ceiling, are Death, Vice, Fire, and Destruction. Some are seated on the top of a column; Vice holds a silver casket, whilst Death stretches forth his skeleton fingers and clutches the handle of his scythe. Destruction, with a flaming torch in one hand, drives the Phoenix or fire bird bridled with golden chains.

The background of cloudy sky is here illuminated by the scorching glare of fire, but the clouds ascend to the peaceful blue of an evening sky, from which myriads of scintillating stars shine forth.



Photo: Arch. Review Photo Bureau.

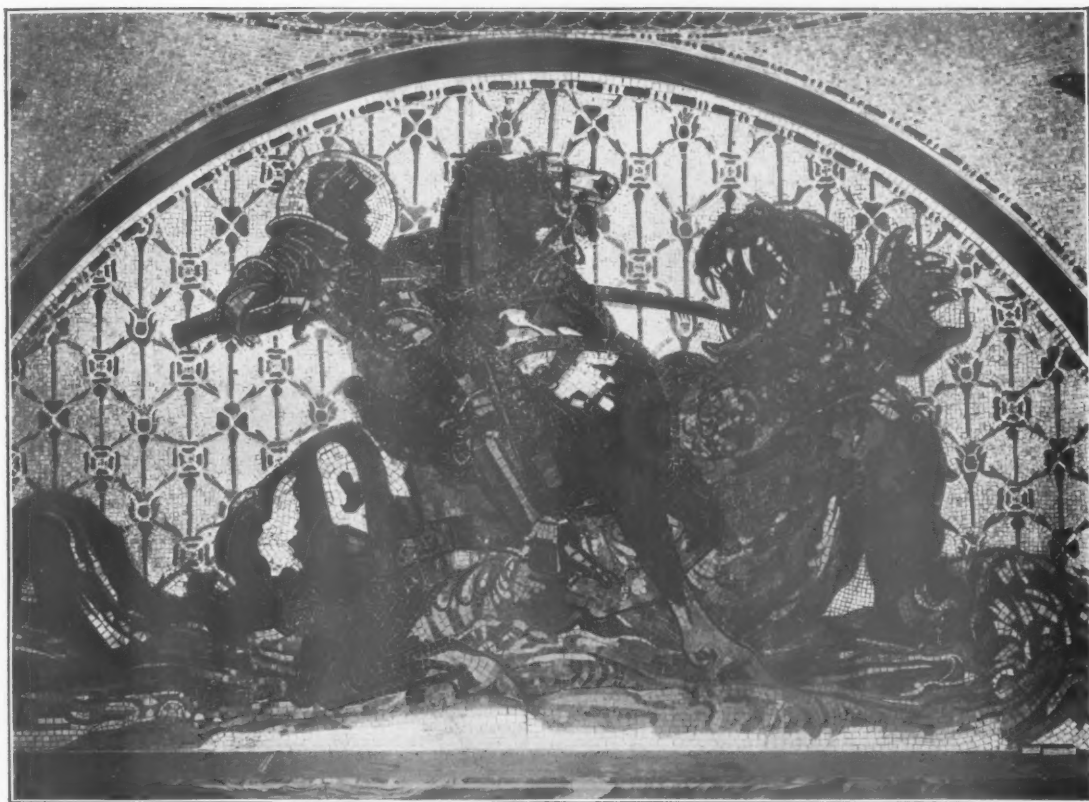
THE GENERAL OFFICE, LOOKING TOWARDS THE ENTRANCE HALL.

The desks, &c., are of polished mahogany. The ceiling panels between the marble ribs are covered with mosaic. The panels or grilles at the top of the pilasters dividing the walls into bays are of ormolu bronze, and act as grilles for the fresh-air inlets. The radiator frames, seen at the floor level, are also of ormolu bronze. The frieze seen in this view shows the end of the third bay depicting "Work" (the end figure represents woman's occupation in bringing up children); the fourth panel, depicting "Courtship," "Music and Dancing," "Beauty," "Painting and Sculpture," "Peace," "The Arts of War"; and the fifth panel (on the right) representing "Charity and Temperance."

*Photo: Arch. Review Photo. Bureau.*

THE PRINCIPAL STAIRCASE.

The staircase is lined with marble, the panels being of Italian pavonazzo framed in Greek cipollino, the cornices and enrichments of bronze being designed by Mr. F. Lynn Jenkins. The steps are of P'iastraccia, the landings being of similar marble with green Tinos introduced. The ceilings are lined with very light Skyros framed in antique Swiss cipollino. The stained-glass window, by Mr. J. Dudley Forsyth, has for its subject "Providentia Tutamen," and owing to its situation of quiet reflected light is carried out in a cool scheme of colour. The female figure of "Providence" supports a child seeking knowledge, below them is a winged youthful figure of "Power," completing the composition.



"ST. GEORGE AND THE DRAGON."

Photo: Arch. Review Photo. Bureau.

DECORATIVE MOSAIC PANEL BY PROFESSOR MOIRA IN THE ENTRANCE-HALL.

The lifts have been supplied by the Otis Elevator Co., of London. The general plaster-work has been executed by John Tanner & Son, of London; and the leaded lights and casements by R. E. Pearse & Co., Ltd., of London.

The whole of the electric lighting and telephones have been installed by Strode & Co., London. The wiring has been carried out on the firm's special steel conduit system, the whole of the cables and wires being drawn into enamelled steel conduits fitted together with screwed sockets

and arranged with drawing-in and junction boxes, so that the cables and wires are always accessible. Strode & Co.'s patent flush switches have been used in all the principal parts of the building.

Messrs. Elkington & Co. executed the bronze work for the frieze, &c., from the designs and models of Mr. Lynn Jenkins and under his supervision.

The general contractors were Messrs. Higgs & Hill, Ltd.

THE UNITED KINGDOM PROVIDENT INSTITUTION.

HENRY T. HARE, Architect.

ARTISTS-ASSOCIATE.—HENRY POOLE (statuary groups on façade), J. DUDLEY FORSYTH (stained-glass windows and mosaic ceilings), PROFESSOR MOIRA (painted ceiling and stained-glass windows), F. LYNN JENKINS (frieze in general office, architectural details, mouldings, enrichments, and decorations in ormolu bronze, and decorative panels in bronze and mother-of-pearl), F. E. E. SCHENCK (low-relief sculptures on upper part of façade, modelled and gilded ceiling to Upper Hall, and enriched plaster-work).

R. B. HOGG, Quantity Surveyor.

JOHN DAVIS, Clerk of the Works.

HIGGS & HILL, LTD., General Contractors.

J. WISHART, Foreman on the Works.

SOME OF THE SPECIAL CONTRACTORS.

J. STARKIE GARDNER & Co.—Ormolu bronze counter-fittings, general bronze work, &c.

H. T. JENKINS & SON.—Marble-work.

RUST'S VITREOUS MOSAIC CO.—Mosaic wall and ceiling linings.

ALLEN & SON.—White glazed bricks.

OTIS ELEVATOR CO.—Lifts.

STRODE & CO.—Electric lighting.

HEYWOOD & CO.—Glass dome to General Office and patent glazing.

BROMSGROVE GUILD.—Electric fittings in Board-room.

W. AUMONIER & SON.—Oak panelling and wood carving.

A. J. ARROWSMITH & CO.—Parquet flooring and special furniture.

R. E. PEARSE & CO., LTD.—Leaded lights.

J. TANNER & SON.—General plaster-work.

*Photo: Arch. Review Photo. Bureau.*

THE UPPER HALL ON THE FIRST FLOOR, LOOKING TOWARDS THE PRINCIPAL STAIRCASE.

This Upper Hall is outside the Board- and Waiting-room, and has three lunette panels (one being seen in the view), with ormolu figures on a background of mother-of-pearl by Mr. F. Lynn Jenkins. Wall-linings, columns, &c., are of Irish green and antique Swiss cipollino, the large pilasters being treated with inlays of the unique blue sodolite from the Princess Quarries in Canada, named after the Princess of Wales, who encouraged their development. The floor is of similar materials to those of the General Office and Entrance Hall. The mouldings are of verd antico. The gilt ceiling to this vestibule is by Mr. F. E. E. Schenck. The small stained-glass window with heraldic design, as well as a larger one (not seen in the view) representing "Temperance," is by Professor Moira.

*Photo: Arch. Review Photo. Bureau.*

THE BOARD-ROOM, LOOKING EAST.

This room is panelled entirely in wainscot; the furniture in oak was specially designed for the room, the upholstery, carpet, and curtains being of a soft green. The electric-light fittings in this room are also specially designed. A detail of the ceiling-painting by Professor Moira is given on a previous page. This painting is set in a border or frame of plaster decoration in heavy relief modelled by F. E. E. Schenck.



Photo: Arch. Review Photo. Bureau

THE MANAGING-DIRECTOR'S ROOM.

This apartment adjoins the Board-room, and like it is panelled in wainscot and has an enriched ceiling, and the furniture similarly was specially designed by the Architect. In the windows of this and the other rooms on the first floor are decorative leads, with the coats-of-arms of the counties and principal cities of the United Kingdom.



ST. PAUL'S CATHEDRAL, WEST FRONT.

From Birch's "City Churches," by permission of Mr. B. T. Batsford.

St. Paul's Cathedral.



FEW things are more interesting, at least to an architect, than to trace through from their beginning the ideas and designs by means of which some great and impressive structures have been evolved.

After the fall of Rome the very great or impressive structures in which fresh feats of construction were essayed were in nearly all cases connected with religion. The examples cited are necessarily churches.

In taking a retrospective view of the buildings of note, we observe that many of them show a startling boldness of conception and execution not in the least exceeded by our greatest engineering triumphs of to-day; more especially is this the case when we bear in mind that the buildings of old were executed under difficulties with which we have not in these days to contend.

Where were the books of measured drawings to which we have access so easily; the tables of breaking and crushing weights and strains; the classified information by the study of which a clever man—for still we cannot do without him—can go "one better" than his predecessors?

We may ask, too, what easy and economical means had even our immediate forefathers of going here and there, and of studying on the spot the various problems solved in the construction of great works?

What boldness was necessary and what reliance on his own resources for the architect to design and construct S. Sofia at Constantinople! What domed buildings had he at hand to study covering even half its area?

What incredible hardihood was possessed by Brunelleschi when he undertook to cover with an octagonal dome that vast area in the midst of the cathedral at Florence—and we must keep in mind that he deliberately made the business far more difficult than need be. His predecessors had provided the space, large as that covered by the dome of the Pantheon at Rome, and, judging by the amount of abutments and the excessive solidity of the structure, it cannot be doubted that it was to be roofed over with masonry. Notwithstanding all this preparation no one seemed to know how the architects had proposed to set up this mighty mass. We see by the frescoes in the Spanish Chapel at Sta. Maria Novella what it was to have been like, and that it was to spring from a line just above the ridge of the nave roof. Brunelleschi, starting from this level, set up an octagonal

drum more than 50 ft. in height and without external abutments, and on the top of this he poised his dome—built, too, without scaffolding from the ground. What previous experience had he to go by? What previous piece of construction, either ancient or of his own time, that even approached the hardihood of what he undertook to do and did? And we still see his work standing after many hundred years have passed over it.

The most tremendous modern works of construction (it is now the engineers who do these things: we architects have quite retired into the shade), with the opportunities which the authors have of study and comparison, almost sink to insignificance beside this extraordinary piece of bold invention, designed and carried out under the difficulties of 500 years ago.

It is designing and carrying to completion some work in which a man is thrown almost entirely on his own resources that fills the mind with such profound admiration, and urges us to learn what we can of the preliminary studies made by the author or authors.

No men have exceeded in masonry construction the wonderful efforts of the French architects of the Middle Ages; but, bold as they were to hardihood, we are able to see how they developed, each man only by a comparatively small degree exceeding the ingenuity and skill of those who were either his contemporaries or immediately preceded him. But we may say of Brunelleschi that he leapt with a bound into space.

If I claim that Sir C. Wren, in designing St. Paul's Cathedral, should be ranked amongst those who conceived and carried through one of the greatest works of invention under the conditions above referred to, it may be thought that I claim too much. I hope, however, to show that I do not.

Superficial observers, amongst whom we must not include architects, often tell us that St. Paul's is a copy of St. Peter's at Rome. Nothing can be more untrue.

All great cruciform churches must necessarily have something in common, but except that each of the two buildings referred to has a dome over the intersection it would be difficult to find two churches more unlike both in plan and construction. It would be as reasonable to say that the cathedrals at Lincoln and Canterbury are alike because they each have three towers. We must therefore dismiss from our minds the false notion that Wren, in designing St. Paul's, had little more to do than to make a *réchauffé* of St. Peter's.

Perhaps the best way to realise actually what he did is for us to picture to ourselves the circumstances with which he was surrounded at the time the designs for the church were made. What were his opportunities? How much had he been able to travel and, by study of examples, to learn? On one occasion only was Wren out of England. He spent a few months in Paris whilst London was being devastated by the plague. This was the one and only opportunity he ever had to examine any buildings carried out in the Palladian manner, then so much coming into fashion, except, of course, two or three pieces by Inigo Jones at home. And what was there at that time for him to see in Paris? The only domed church of any pretensions then erected was at the Sorbonne, a very modest building when compared with the great domed structure he had soon after to design. The frigid eastern façade of the Louvre was being built, and Wren in his journals expresses his admiration for the engines used in raising the very great stones employed. Neither St. Sulpice nor the Pantheon was built. Wren states that he bought a number of *taille douce*—engravings, no doubt, of the buildings then built and building in Rome.

So he came home again equipped with some engravings and the sights of a very few specimens of the Palladian then creeping into Paris, but which, happily, seems never to have got much footing there. How different were his opportunities from those of the architects of to-day!

We must remember that Wren had already designed a central dome to be set up on old St. Paul's. In designing this he seems to have been as bold and brave in his intentions as he was after he had been to Paris. His scheme for removing the centre tower and, following the example of Ely, replacing it by an octagon, gave him a dome about as large as that he afterwards erected. The drawing (now at All Souls) gives us but a very slight idea as to how he actually proposed to construct the dome. Then came the destruction of the old cathedral and the task of designing the new. At once we are brought face to face with Wren's originality and inventive powers. In St. Paul's Cathedral there exists the model, most carefully made in all respects, of the church he proposed to erect, and which for practical reasons of use we may be very glad was not constructed. No doubt the great dome at St. Peter's had so completely established itself as the one and only central feature a big church could possess, that every scheme made by Wren always centred round this. But from what source did he get his plan? He had not Fergusson's handbook to look into, and if he had he would not have found any plan or scheme of treatment similar to that which he evolved.

As a church, even for preaching purposes, the plan is certainly bad; for choral purposes, jejune and shrivelled as the services had become in his time, it was unsuited. Unless it had been carried out at nearly twice the dimensions he proposed it would have been very inadequate for present-day uses. As an architect's dream and as a piece of ingenious construction the interior was as original as it was beautiful.

It is, indeed, well deserving of close study. As we know, Wren thought a great deal of "the good Roman manner" as he called it. And what was this? A parade of classic detail, but applied then, as it is now, without meaning; a mere surface pattern concealing and falsifying the real construction, belying the true architecture of the building.

In Wren's day the active energy of the Renaissance was still strong—the Renaissance to which we owe so much in all the arts except that of architecture. Wren must make use of the language of the day. How does he express this in words when he is called upon to make a fresh design for St. Paul's? He says that he wishes "to reconcile as near as possible the Gothic to a better manner of architecture." Architecture, according to this, must mean trimmings and not the essential anatomy of the structure to be designed.

How far does his genius bow to these false suggestions? We shall see that as we go on. A study of the first design for the cathedral shows us a building which, in the interior, divested of its trimmings, has nothing whatever about it that belongs essentially to "the good Roman manner." It consists of a most masterly arrangement of piers and arches, so placed as to be of the greatest constructive value and at the same time to produce the maximum of effect. The interior, encrusted with marble slabs and adorned with gold mosaics, instead of with many pilasters, would have very well taken its place as a building in the Byzantine manner, and a very noble one.

The exterior was adorned with the inevitable portico at the west end, surmounted by a pediment. The equally inevitable "order" was plastered on the side walls, without any relation to the interior, and was surmounted by a clumsy and ill-proportioned attic, an influence no doubt from St. Peter's.

The intercolumniations of the "order" were pierced by windows of various sizes, while the attic conveniently hid the construction of the various roofs, and of the abutments of the base of the dome. Quite, in this respect, in the true modern "Roman manner." May it not be considered that the flanks of the church in this design are even commonplace?

Then we come to the dome resting on the drum surrounded by buttresses as in the existing building. In the design of this, as in that of the interior, Wren is beholden to no man. He is all himself. The relation of the dome to the drum from which it springs and to the structure below, the relation of the lantern to the dome, the beautiful curve of the dome itself, the extreme simplicity and majesty of the whole, are most striking.

As in the existing cathedral, so to a less degree in the model, the buttresses around the drum are disguised. We may ask, Why should they be disguised at all? The answer is clear. Such things are not found in "the good Roman manner." The arches joining the buttresses are honestly displayed, and were it not for "the dead hand," as Professor Lethaby so aptly calls it, the pretence that that which is a series of arches is in fact a piece of trabeated construction propped by arches, we should find a perfectly true piece of architecture.

I think it must be admitted that in the design for the model Wren's genius proclaims itself at once as quite original and yet without effort; perhaps a little hampered by the stock pattern book, but in all essentials riding clear above it.

This scheme was not accepted. It was not found to be of the approved cathedral form, nor with its central feature sufficiently lofty to remind the Londoner of what he had lost—a steeple which had been the highest structure in the world. So, on the basis of the cathedral plan, especially English and reminiscent of old St. Paul's, viz. with an eastern limb almost as long as the western, Wren again set to work, and undoubtedly took sundry hints from Ely.

It was in preparing this second design that Wren decided "to reconcile, as near as possible, the Gothic to a better manner of architecture." We can see in the design before referred to, for a central feature to be set up in place of the great tower at old St. Paul's, how the interior of the Norman nave of that great building was to be "reconciled." He proposed to put a skin over the massive clustered columns, to place Corinthianesque capitals in various places, and to give us something which, if any merit at all had been left to it, would have been that inherent in the original building, and certainly not in the skin-deep "better manner of architecture" with which it was to be encrusted and disguised.

The treatment here proposed shows us that Wren was of opinion that architectural effect depended on "trimmings," but, happily, his acts and his words did not quite agree. The glories of St. Paul's owe little enough to this "better manner," but how much are they not owing to Wren's genius and good taste?

It is now my duty, in praise of my hero, to show if I can wherein Wren the man of genius triumphed over Wren the pedant; how, with amazing skill, he solved many difficult problems; and how much, in doing this, he must have relied on himself and on his own observations, how little upon tradition or inherited skill.

The mediæval tradition was already broken. The last big churches that had been built were, I suppose, Bath Abbey, the Chapel of Henry VII., and King's Chapel at Cambridge. I say this under correction. How different in their masonry and methods are these to the work at St. Paul's! From the first quarter of the sixteenth century to the last quarter of the seventeenth century, what a gap it is, especially at this period in our history!

Wren was a close observer, and had made careful studies of sundry mediæval buildings. His reports thereon show this. He must also have made a minute and careful study of old St. Paul's. His mind was thoroughly impregnated with the bold and ingenious methods of construction made use of by his countrymen—a boldness combined with economy of material, opposite in the extreme to the piling together of masses of masonry prevalent in and before his time in Italy.

But let us reflect for a moment on what he had to do. The site he was to build on was cumbered with mountains of material, some of it still standing, sound and strong, but built for the most part of indifferent stone, much of it damaged by fire. In the middle of this chaos he had to plant his new church. Here, at once, his invention comes in. He tilts the axis towards the north, and so to a large extent finds unbroken ground on which to plant his foundation. He examines carefully the nature of the ground and finds that the solid London clay is 40 ft. down, a depth which we may suppose was in his days looked on as quite out of the question, except under the dire necessities he was put to at the N.E. corner. He finds that the old church, an exceedingly weighty structure, had stood very well on the layer of "pot-earth" which covered a bed of gravel. If the old building stood on that, why not the new? Then his ingenuity at once comes into play. Nowadays, it is nothing to us to float heavy buildings on beds of concrete, to build in iron rods or rails or what not, or, with various means we have at disposal, to sink deep and capacious shafts here and there to the solid. Wren had to think out the whole thing, and devise his ingenious method of floating his building.

In Fig. 1 we see on plan the method which he adopted to distribute the weight, whilst the section Fig. 2 shows how the eight piers, 30 ft. by 10 ft., were steadied. The plan of the structure

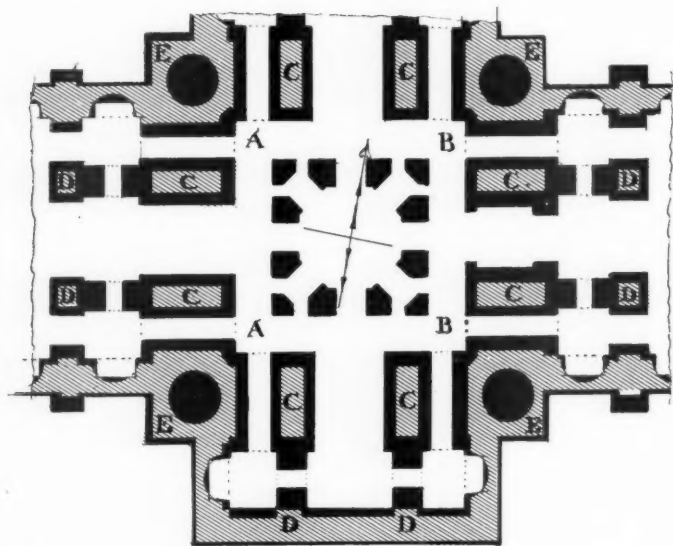


FIG. 1.

on the floor level of the church is shown in Fig. 1 superimposed on the substructure at the level of the crypt floor. The value of the conical structure can be traced in Fig. 2 even down to the lowest levels of the building.

He joins up the bases of the eight piers CC (Fig. 1), by masonry practically continuous, to the bases of the piers in the nave, choir, and transept which come near them DD, whilst he also joins these same bases CC to the bastions EE by masonry of the most solid description. He seems to have taken every precaution that nothing should slip. The very massive piers which carry the floor of the dome—far more massive than was required merely to carry the weight of the floor—seem also to suggest the idea that Wren set great value on the rigidity gained at the floor level of the church by the series of vaults in every direction which he placed there.

A glance at the section Fig. 2 shows clearly how the conical idea is carried out, how the greatest stability is gained with the least amount of material. The upper cone rests on the lower cone pierced by the windows which light the interior, and this is again spread out upon the backs of the four great arches and of the four half-domes which bear the superstructure, circular in plan, upon the base, square in plan. The weight descending vertically is borne on the piers C and spread out laterally to D.

The way in which the structure which carries the dome is spread wider and wider until it covers an area of 250 ft. by 250 is very ingenious. We know that the centre towers at old St. Paul's, as at Salisbury, had been assisted by a very ingenious engineering arrangement of flying and other buttresses. These may have given a sug-

gestion to Wren, but the way he has done the work is all his own. One cannot suppose that the *taille douce* gave him hints.

So here he has conquered, in his own way, and without previous examples, some very difficult problems. Then comes the all-important question, the dimensions of the points of support of the dome, and their materials. Granite, vitrified bricks, concrete, and the sundry and one ways and means we have at command, he neither had nor could see in use. Tables of the resistance of materials and the strengths of cements and mortars he had not. The hardest available material was Portland stone. An examination of the cathedral shows us at once the difficulties he had to overcome. The com-

mittee required something which did not depart "too far from the Gothic." They wanted, at least for the plan, a reminder of the majestic structure that was to be removed, and Wren saw at once what to do, making as he did a modification of the plan of Ely Cathedral, which, from

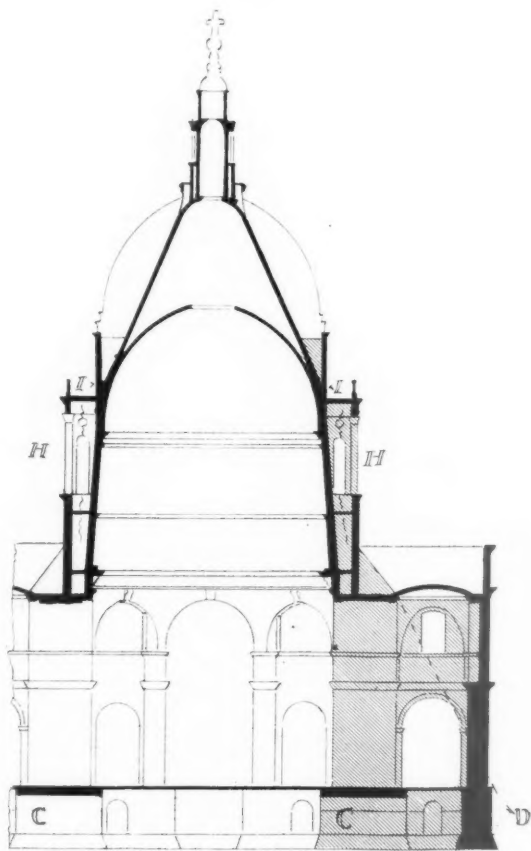


FIG. 2

family associations, he knew so well. But at Ely the octagon is vaulted and roofed entirely in wood. It rises but very little above the ridges of the roofs, and in height forms no commanding central feature. Wren was to combine space with a height sufficient to remind the world of the departed glories of the older cathedral.

Piers amply sufficient to carry the wood structure would have been altogether inadequate to support the huge superstructure he contemplated. He had to design adequate piers and yet thread through them the necessary "long-drawn aisles."

In constructing the dome at St. Peter's no such difficulties presented themselves. The plan in that church is that of a Greek cross. There is no place for long aisles or side vistas. At Florence the nave aisles are carried through into the octagonal area under the dome, but we may question whether this is done successfully. The aisles end in what is little better than a couple of tunnels chopped through the piers.

So Wren had to solve the difficulty his own way, viz. by making the eight piers rather thin but of considerable length, about 9 ft. by 30 ft., measured on the pavement level of the church. The vertical weight of the whole superstructure rests on these points of support, and notwithstanding the settlements that have taken place there are none which can be attributed to any miscalculation of strength or imperfection of construction in these piers.

These eight piers carry four great tunnel vaults, and the thrust of these vaults (bearing on their backs a prodigious weight) is carried onward in a direct line to the four bastion-like masses which form so majestic a feature in the exterior view of the church. For we must keep in view that the dome of St. Paul's rests, not on an octagon, but on a square, at the angles of which are the bastions.

The accompanying diagram, Fig. 3, shows us that in relation to the great thrust passing through the side arches FG and FG to the bastions EE, these bastions form buttresses of no great depth in the direction of these thrusts. The thrust is also received very high above the ground, and is not only in the directions above indicated, but also in an outward direction, received from the half-domes over A and B, on each of which half-domes rests an eighth part of the total weight of the superstructure. How did Wren get over this difficulty?

In showing how this was done, I shall have to speak in praise of one of those things which the critics, the superficial critics I will venture to call them, who merely look upon the surface, have agreed to condemn. The exterior of the church is decorated, as we know, with two orders of

pilasters. The upper order clothes a great wall surmounted by a balustrade, but for more than a third of its height this wall has nothing behind it, the lead roof of the triforium over the aisles being nearly 30 ft. below the balustrade.

The critics tell us that this wall was merely set up to hide the flying buttresses which resist the thrusts of the nave and choir vaults. A glance at the diagram (Fig. 3) shows that this wall has a most responsible and structural office to fulfil. The drum of the dome stands over an area that is square, AB on plan (Fig. 1). The preparation for the circle begins at a height of 65 ft. from the floor, at the level of the eight great arches. To resist the thrust of the four great arches of the crossing lesser arches spring from the same level, FG. and FG., and span the aisles (Fig. 3). These arches in fact continue the square form of plan, taking the thrust directly on to the angle bastions EE. The weight carried by each of the four great arches, an eighth part of that of the whole superstructure, is sustained by piers 30 ft. long it is true in one direction, but less than 10 ft. through in the direction of the thrust. The arches FG, FG carry on the thrust.

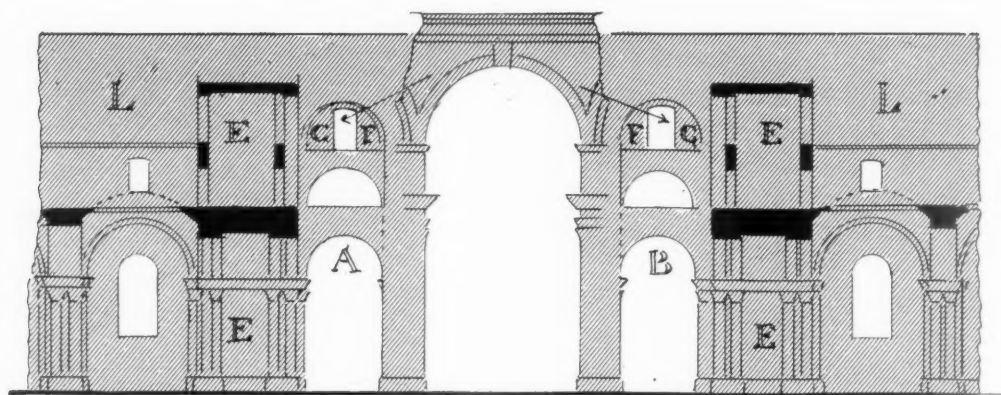
Wren evidently did not think the bastions EE were sufficient of themselves to resist the strains imposed on them.

To form an idea of the immense superstructure resting on the arches we must reflect that if set up on the elevation (Fig. 3), we must add a height of more than two-and-a-half times above the highest level shown on the drawing.

The section shows us that the great piers are steadied at the level of the aisle vaults by tunnels. How solid in construction these may be we do not know, but it is clear that the most severe action of thrust does not come into operation until we reach a level of some 70 ft. above the church floor and in the directions FG, FG.

The walls, with windows in them which are shaded with a half tint, are quite thin, and have no real value in giving rigidity to the great piers.

Just as the great piers 30 ft. by 10 ft. are assisted in the direction of their length by the walls of the clerestory, so the bastions are stiffened, in opposition to the line of thrust, by those great walls, L, which assist in distributing the thrust over the largest possible area. We cannot doubt that had Wren put a sufficient mass of material into the bastions, EE, to resist the thrusts, these would have become so ponderous as, on the unsatisfactory subsoil, to have caused danger by their subsidence. Had they sunk more than the eight dome piers, what terrible results might have come about; but, designed as they are, the tendencies of the various parts of the structure are, in

FIG. 3.¹

the event of subsidence, to lean towards each other, as they do in the buttresses of the drum overhead. Wren provided for that which he used his utmost efforts to avert. I must again say for my hero, that the longer one has lived in the building and examined it from every point of view, the more is one overwhelmed with veneration and astonishment at the surprising resourcefulness, originality, and prescience of that wonderful man. Whether it be to poise several thousand tons of masonry in the air or to provide for a rain-water pipe in the best way, nothing is forgotten.

Another ingenuity of construction is also well worthy of observation. This is to be found in the drum of the dome (see Fig. 2).

Viewed from the outside we see rising above the roofs a sweep of unbroken wall. This forms a base upon which stands the stately range of columns H H, which support the balustrade of the "stone gallery," as it is called. But, as a matter of fact, we do not look upon a range of columns, but upon the outer edges of a series of buttresses set at right angles with the drum. The purist must raise the objection that here Wren has used "the better manner of architecture" at the expense of truth. Undoubtedly he has, but in his masterly hands the result is so superb that we must condone the fault. The series of thirty-two buttresses are gathered into eight groups by filling in the intercolumniation over each of the great piers on which the whole mass rests. Within two of the filled-in spaces thus formed, winding stairs are taken up to the stone gallery. The other six are tall empty shafts. The stonework forming the sides of these shafts at right angles with the drum is by no means thick, not more substantial than that which forms the other sixteen buttresses. Judging by other devices used, where the drum rests on the great arches it seems to have been Wren's desire to make the

whole of the drum of equal weight in the entire circumference. The sixteen buttresses which are terminated towards the spectator by—as he thinks—sixteen free standing columns, are pierced by arches and circular holes above them. The whole of this work is executed in excellent ashlar; and all parts of the walls being comparatively thin, the stones, by no means large, are carried through. So as in all possible ways to avoid vertical joints, the section (Fig. 3) shows us the method of construction adopted. The columns of the colonnade are surmounted by an orthodox entablature; but this is entirely false, a mere screen hiding the ingenious structure behind it. The buttresses are, in fact, surmounted by a series of arches set at right angles to the wall of the drum. These, using but a comparatively small quantity of material, form a ring of great rigidity set at right angles to the thrust of the base of the cone.

It will be observed that the weight of the superstructure rests very much more on the inner ends of the eight great piers which carry the dome than on the outer ends. Wren endeavoured by various devices to distribute this weight, and probably had he been able to obtain long, hard stones of considerable size he would have succeeded. Unfortunately for him the materials at command were anything but large in scantling. Excepting the fine ashlar work used for the colonnade and buttresses, the stone used for the other parts of the dome structure are decidedly small, whilst a great deal of the work is of very good brick. The sinking of the eight great piers set up movements overhead, and in effect the whole of the drum with the inner dome and the cone over it sank, leaving behind them the outer ends of the buttresses, which we see as the columns of the colonnade. The arches before referred to, and the round holes above them, are all more or less cracked, and consequently the outer part of the

¹ It should be stated that Figs. 1, 2, 3 are diagrams only, but not scrupulously accurate as to scale or detail.

buttresses is separated from that which abuts upon the drum. Here we observe the advantage gained by the inclined wall of the drum, that wall pierced by windows which we see from inside the church. The section of the drum (Fig. 3) shows us that although this settlement has taken place, the tendency of the buttresses is to fall inward against the drum, and that is certainly the fact. Within the last five years every part of the drum has been carefully gone over, and all cracks and damaged stones have been repaired. Whilst the dislocation of the arches in the buttresses was very manifest, the inner half of the arch having in some cases sunk very considerably below the outer half, there were not any gaping cracks. The buttresses seemed to be doing their work perfectly well.

To increase the rigidity of the ring of arches which surmounts the buttresses and tie their outer ends—the colonnade—to the drum of the dome, Wren made use of iron ties anchored into the drum and over the columns. A little above the inner ends of these comes the "great chain" (I), as it is called in the "Parentalia," which embraces the spring of the cone.

Wren, unfortunately, made use of iron cramps and ties in many places, following, as so many of us are apt to do, "the good Roman manner" without remembering the immense difference there is between the climate of London and of Rome.

Iron cramps stand well enough in Italy when but a very little way below the surface. Not so in England. The damp has, in the case of St. Paul's, penetrated to the cramps, and they have exfoliated in an extraordinary manner, splitting to pieces the stonework they were supposed to fortify.

Seeing how terribly the iron had in many cases acted as a destructive agent, and seeing also how exceedingly important the iron ties were which extended from the drum to the colonnade, it became a matter that could not be neglected to ascertain the condition of these ties.

I was the more apprehensive because the pavement of the stone gallery, a series of large slabs draining into a stone trough, was very much worn. The movements in the building must have caused the joints in the trough to open, whilst the slabs were so uneven, worn by the feet of countless sightseers, that the rain-water stood in pools and soaked the slabs. It was evident that water entering the filling in, on which the slabs rested, would sink between the haunches of the radiating arches above the buttress, rust the iron, and in time weaken most seriously one of the chief abutments of the dome and cone.

Some stone slabs were lifted. Underneath was a fine close bed of lime, mortar, and pieces of

stone, a species of concrete which, where we raised the stones, seemed none the worse for any wettings it may have got. The iron ties were, however, some six or eight feet lower down, so we dug through the mass. Excavation was carried on some 200 feet above ground.

At last the tie rod was reached. There it lay in the most perfect condition—almost bright. It was a matter of no little joy to see the excellence both of the bar and of the filling in—one could feel assured that the ties were still doing the work Wren had designed them for. To ensure that no moisture shall hereafter get into the backs of the arches, the stone trough is now lined with asphalt and the slabs forming the floor of the stone gallery are covered with the same impervious material.

All the iron used in the building of St. Paul's is charcoal iron—presumably from the Sussex furnaces. We see that, the air excluded, it remains in perfect condition for 200 years.

It would perhaps have been wise to search for the "great chain" and to ascertain its condition, as it lies comparatively near the outer surface of the attic wall above the colonnade.

Mr. Penrose had told me some time before that in carrying down the circular stair at the N.E. angle of the choir so that instead of going merely into the churchyard it gave access to the crypt, he found the heading of the wall to be composed of many stones from the old cathedral set in lime mortar, admirably compounded, which he compared with the mortar found in ancient Roman buildings. It was through such well-compounded material that we excavated to reach the iron ties.

Wren had been told by his Committee that they wanted a building which did not depart too far from "the Gothic." Except the cathedral at Bristol all our cathedrals have a lofty nave and low aisles, as had old St. Paul's. The great triforia, practically an upper aisle, so common in Norman churches, did not suggest to him a way out of his difficulty.

Wren had not seen some of the great churches of Spain, where, as at Malaga, Diego de Siloe has, with Italian detail, given us a Gothic church with the aisles as high as the nave. Retaining every part which he felt to be essential to stability, Wren could have very easily roofed in the space which is now a mere well to light the clerestory window, and he need not have departed far from the "Gothic" as understood by his Committee.

He required his continuous abutments, and we may be thankful that, at least for external effect, he provided them as he did.

The tremendous mass of masonry, fully 100 ft. in height, as seen from the churchyard, and pierced by so few openings, forms a most fitting

basis for the glorious superstructure. Whatever its faults may be it remains more majestic and glorious than any similar structure whether built before or since.

If we compare Wren's method of building the great central feature of St. Paul's with that employed at St. Peter's at Rome, the only rival he had, we shall find that the difference could hardly be greater.

It is evident that Wren was a close student of the great mediæval churches of England, and in these he found most excellent examples of scientific construction, combined with remarkable economy of material. We learn in the "*Parentalia*" that he thought the builders of the Middle Ages little better than barbarians; but he did not hesitate to use their methods, and, in result, his great masterpiece is built in all respects completely on mediæval lines; not in plan only. It is, however, disguised as far as possible beneath a trimming of "*the good Roman manner.*" Wren was in difficulties about his west front. A portico or protection to his great doorway seems to be a necessity. In his earlier plan he proposed to erect a portico of one very large order of Corinthian columns, rather a dull-looking affair, judging by the model. He found, however, that he could not get from Portland stones of sufficient size to give him drums for these large columns; and here, at once, his care for good construction comes to the top. He knew how undesirable it was to have vertical joints in a column, so he adopted the only course open to the true architect: he suited his design to the materials he could obtain. The largest stones he could get gave him columns of 4 ft. in diameter, and these he used. But his façade was 100 ft. high, so he thought the matter out for himself, threw the copy-books and the "*dead hand*" to the winds, and designed the exceedingly magnificent façade we now see, and which has, of course, been severely pulled over the coals by those dreary critics. The grouping of the columns and general treatment is surely abundant evidence of the resourcefulness of Wren, and whence did he get his suggestion for such a design except out of his own head? The difficulty is triumphantly overcome.

Then it is said the side chapels, one behind each of the towers, were forced upon him by the Duke of York. Satisfactory evidence for this I have not seen, nor, excepting in the way the chapels absorb the lower stories of the western towers, do they appear like afterthoughts. If the statement be true we can but admire the magnificent internal effect which our architect obtained, by widening the first bay of the nave and combining with this the arches, columns, and screens of the side chapels. I venture to believe that no building whatever has a more nobly designed

entrance than St. Paul's. Wren mastered the difficulty and turned it into a triumph.

Notwithstanding the horribly coarse and vulgar architectural trimmings in St. Peter's, we must admit that, in general proportions, the interior is superior to that of St. Paul's, but it has nothing to put beside the western vestibule and chapels. I venture to affirm that all the best features of the interior are seen where we find Wren thinking for himself and designing what he wanted, and not making use of what he found in the pattern books. To the western bay and vestibule we have already referred. The inevitable "*order*" with its cornice is plastered on the inner face of the piers, and goes far to ruin the effect of the eight great piers of the dome. We are asked to believe that the vast superstructure is poised on eight equal arches which rest on eight columns only 4 ft. wide and are folded up the middle. But if we examine the treatment of the piers of the arcades, omitting the great pilasters, we find that Wren has thought for himself. He keeps the surfaces of them, masses of masonry 8 ft. square on plan, very flat. The bases on the floor are not broken at all, the surface pilasters have but little relief, and above the capitals he draws the whole thing together once more by a simple cornice—not in the books—which is as unbroken as the base, except by the useless pilaster which, with the pennyworth of frieze, looks singularly weak and out of place. The "*style*" was too much for him when he got to the apse. I am unable to recall a single instance of an apsidal end with windows which "*in the better manner of architecture*" is successful. The untractable lines established by the trimmings of useless pilasters and entablatures have always beaten the architect, and at St. Paul's the strange way in which, on the exterior, the real windows are seen emerging from below and trying to get themselves into the openings provided for them is in no way successful, whilst in the interior the sudden drop of level from the clerestory windows to those of the apse is equally unfortunate.

To return to the outside, it will be found that Wren was very free in dealing with the two "*orders*" which overlay the walls. The frieze and cornice of the upper order he quite takes possession of and throws it into the cornice of his great walls. He does the same with the entablature of the upper pediment, and, be it observed, these pediments are not great constructive members used merely as an ornament, crawling aimlessly up a wall: they are what their originals were—real gables.

Where did Wren get the suggestion for the masterly design of the western towers, so beautiful in their variety of plan and juxtaposition of line,

so wonderfully adjusted to their place and to contrast with the vast majesty of the dome behind them. How much bigger they are than anything he had designed before, and yet how right they look! The same remarks apply to the dome. Compare the subtle curvature of Wren's dome with that of the painful eruptions which have of late been forcing themselves upon the sky line of London in all directions. One may invite the reader to observe how easy it is to get wrong by asking him to compare Soufflot's dome of the Pantheon at Paris with Wren's at St. Paul's. Wren had very much studied the outline and effect of the dome of St. Peter's. There are several drawings extant which prove this, but neither in the model nor in the actual work did he find that this type was suited to his needs. His dome was to be a much more imposing crown in relation to the whole structure, so he thought out something he felt to be more appropriate.

Soufflot had Mansard's beautiful dome at the Invalides and Wren's at St. Paul's to study, not to mention St. Peter's. He took parts of Wren's design, a colonnade with an attic and the cupola above, and what a poor feeble caricature he produced! At St. Paul's Wren plays freely with the types of the capitals to the dome colonnade, departing altogether from the book, and when he comes to the top of the dome, to the great stone moulding which crowns it and carries the "Golden Gallery," he runs off quite on his own account. This moulding is a tremendous thing close at hand, but how exactly right it looks from below, neither too coarse nor too small. The more one studies the graces and beautiful outline of that wonderful structure, the curve of the dome, the strong horizontal lines with which he binds it together at the spring, the noble dignity of the colonnade, with its unbroken entablature sweeping round, the subtle variety in the lanthorn (which in true elevation is surmounted by a dome of very odd shape, but just right up there), one is forced to appreciate that Wren was indeed a very great artist, an architect in the fullest sense of the word, for he not only had unlimited resources in himself in overcoming constructive difficulties, but he accomplished his end by means that were nearly always beautiful in result.

When we examine a ground plan of St. Paul's Cathedral showing the church at the floor level, we get but an imperfect idea of the way in which Wren spread out the substructure so as to float the building on the largest area of the thin stratum of "pot-earth" on which he was compelled to build. To appreciate his care, we should, having examined the floor plan of the church, proceed to study that of the crypt 20 ft. below it, and at an average level of six or seven

feet below the churchyard, and then appreciate that in most cases there are stepped footings which spread over an even larger surface. (See Fig. 1.)

The plan under the west front at the crypt floor level shows an extraordinary mass of material, more than seems necessary for the work as executed, for we find nearly the whole space under the void of the portico a solid mass of masonry. This is, however, to be explained from the fact that at one time Wren had proposed to place columns within this portico dividing it into a nave and aisles. There are drawings in the cathedral which show this. On this great mass of material stands at the north and south end a tower, 40 ft. square at the base, and rising to a height of fully two hundred and fifty feet above the lowest course of these footings. Between the towers is the void of the portico.

The footings of the towers are spread out with many steps; but notwithstanding the precautions taken, they have each of them sunk, and in so doing have spread outwards; the north tower but very little, the south tower so much that it has a distinct inclination towards the south-west.

The west wall of the church, or back of the portico, which is pierced by the great doorway and window above it, has split in half from the top to the bottom. The horizontal door-head gives but slight indication of the movement, but the window-head above has suffered seriously, as shown by the photographs (Figs. 4, 5, and 6).

As we ascend the great flight of steps which leads us to the portico, we may observe that they are not horizontal, but are laid on a curve, the centre rising above the north and south ends. The plan and arrangement of these steps (except the curved surface) are such as was originally intended by Wren. They are thus shown in his drawings preserved in the cathedral, but were not so carried out, as after he had faithfully served the church for forty-eight years he was turned out of office, and a perfectly ignorant person—one Benson—was put in his place. Under Benson the steps were finished, not following Wren's design.

About thirty years since the heavy cast-iron railings with which the area before the west front was enclosed were removed and the space thrown open as we now see it, and at the same time the great flight of steps, which stood in need of repair, was reconstructed, following Wren's own plan.

I had supposed that, possibly, the subtle curvity of the surface had been made by Mr. Penrose, remembering the beautiful effect of the same treatment which we see in the Parthenon at Athens.



FIG. 4.



FIG. 5.

Photos: Arch. Review Photo. Bureau.

Mr. Penrose told me, however, that the curvature was of necessity. The two ends of the platform having gone down, he found himself in the following dilemma: If a horizontal line were taken from the north to the south end of the platform, adopting the datum given by the doorways into the aisles, he found that the square bases on which the central columns of the portico rest would have stood up some inches higher than those at the ends. If he adopted as a datum the floor level given him by the central columns of the portico, a horizontal line would have gone far to bury the bases of the columns at the north and south ends. So he made the platform and steps follow the line of curvature caused by this

settlement, whereby all the bases and door sills stand in their true relation to the platform above which they rise.

The reader will be able to appreciate by personal observation how far the west front is from level even as near the ground as the floor line. The south-west tower shows, when examined from within, that its angles have sunk very slightly; there are dislocations to be seen partly through the sinking of the corners, but the chief movement has evidently been that of a bodily descent of the whole mass which has caused this considerable movement in the adjacent structure—one through the chapel immediately east of it, the Chapel of the Order of St. Michael and

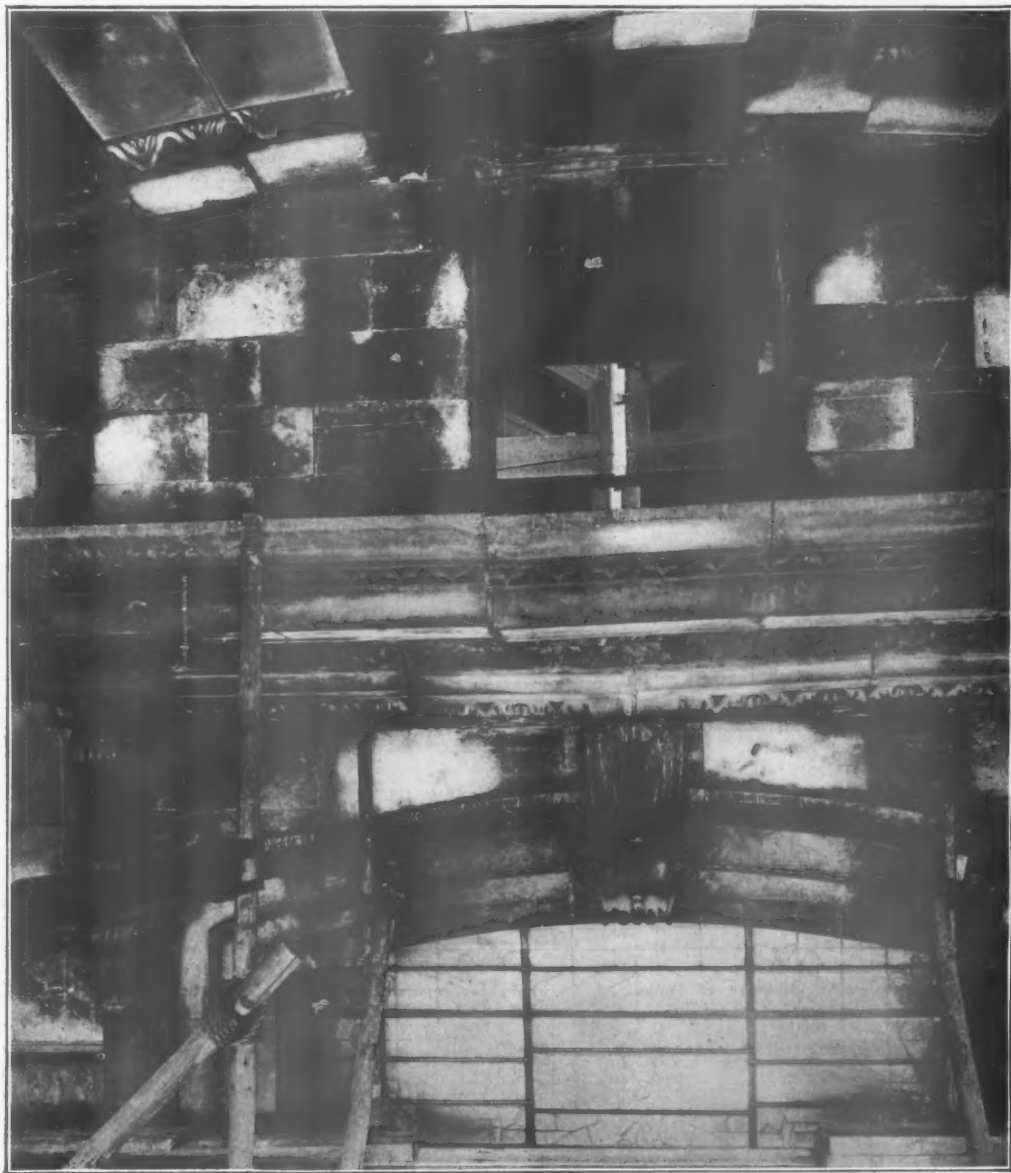


FIG. 6.

Photo: Arch. Review Photo. Bureau.

St. George; the other, already referred to, through the west wall of the nave.

The dislocation in the chapel can be traced down to and below the church floor. It passes through the sill of the window. It has given rise to a curious dislocation, very perceptible in the middle of the vaulted ceiling. From the churchyard this movement can be clearly traced for its whole length. In the library above the chapel the results of the descent of the towers are equally visible, both in the south wall and in the vaulted roof. There is every appearance that this movement began and took a very manifest shape long ago. The question is now whether there are not evidences of fresh danger. As of the dome piers, so of the walls of the cathedral at the places now under consideration, there is nothing to show that the structure is at fault. The evil is clearly below the footings.

The portico of the west front, rising as it does in two stories, is covered at each level with a coffered vault of Portland stone, about fifty feet in span, but not rising above the springing line more than some eight feet (see Fig. 5). There are thus two very flat vaults sustained by thrusts against the structures north and south of them. As might be expected, the upper vault has shown very much greater signs of dislocation and movement than the lower. Whilst the lower springs at a level of some forty feet from the church floor, the upper springs at a level of about eighty feet. Whilst the lower vault is to some degree steadied by the brick walls which lie on the back and carry the pavement of the upper portico, the vault of the upper portico has only to carry itself, and is in no way steadied by any superincumbent weight. The photograph (Fig. 5) gives but a slight idea of the dislocation that has taken place. As these vaults stand quite independently of the walls at their sides, and form an integral part of the structure at the springing line only, the stones of which they are formed—of about eighteen inches in thickness, with coffers sunk out of that thickness—were free to move, and had taken great advantage of the freedom. Walking over the back of the upper vault one could see through the crack between it and the back of the pediment. The stones had moved, some settling on the line of the long axis of the curve, but others in a far more perilous way had settled on the transverse line. A rule could be pushed between many of the stones, whilst at the joints the soffit of one would be more than two inches below that of another, the voussoirs being held in place by pinching at the extrados and not at the intrados. This, of course, shows that unintended thrusts were being exerted against the back of the pediment on the west and the wall over the west

window on the east. This wall was a poor flimsy piece of construction, remarkably unlike that to be found in most parts of the cathedral. It was to be wondered at that the thrusts exerted against it by the dislocated vault had not caused it to yield. Had it done so, the arch must have collapsed. The pediment, perilously balanced on the top of the two stories of columns, and already showing a slight inclination to move westward, was equally ill suited to resist a thrust never contemplated by the architect.

Figs. 4 and 6 show how considerable have been the dislocations consequent on the west wall of the church being cracked through.

The voussoirs of the window arch have, some of them, descended bodily. The heavy and far-projecting cornice which rests on this arch has sunk. The centre stone of the cornice was very insecure, as it had but very little counterpoise over the tail, there being a doorway over the window through which we look in Fig. 6.

The arch stones and those above them have all been reset; whilst the vault, by sawing through the joints and wedging between the stones, has been got accurately into its old position, tied together across the springing line by heavy 3-in. rods of manganese bronze—a material which will not be affected by the foul atmosphere the Londoner delights to breathe.

Reference has already been made to the south-west tower, which, although it has moved, seems in itself perfectly solid.

The following facts are, I venture to think, a pretty good proof of this. Just above the level of the clock face hangs Great Paul, which with the metal collar in which it is suspended forms an oscillating mass of metal weighing about twenty tons. The bell is hung very high in this collar, so that the weight of the lower part of the bell is to a great extent balanced by the weights of the upper part of the bell and the horseshoe collar to which it is fixed. The bell is swung daily, and is raised until it is nearly horizontal. It swings east and west. The bell frame consists of a great cage of wood and iron carried some distance down the tower below the clock face. This frame lies east and west. Here we might fairly think is an engine especially devised for trying the stability of the tower, and for driving further towards the west that which already overhangs somewhat. Immediately under the bell, and nestled between the deep girders of the bell cage, is set the clock, which rests on rolled joists separate from the bell cage, but not at a lower level. The pendulum of the clock swings east and west. If the tower oscillated when the bell was swung, the clock would infallibly tell the tale, but there is no tale to tell. The clock goes calmly on its way, and

keeps admirable time whether the bell is rung or not. I believe a better test of stability could not be devised. For more than twenty years the bell has been swinging.

It has been stated that the north-west tower has also moved. There are cracks through the north-

west chapel and the room over it, but not on so large a scale as those behind the south-west tower.

In the north-west tower hangs the peal of twelve bells, the tenor weighing not less than 62 cwt. It is probably the heaviest peal in existence. We all know how often the ringing of bells in peal has proved most destructive to the towers in which they hang, and have no doubt, most of us, felt the considerable oscillation to which a bell tower is subjected—a thing not necessarily harmful.

When the bells were in full volley I took a mirror to the highest accessible part of the tower, and setting it securely on the stonework projected a ray of light on to the north face of the opposite tower, a distance of a good 100 ft. Not the least vibration could be felt, nor did the ray of light tremble or show any sign of movement.

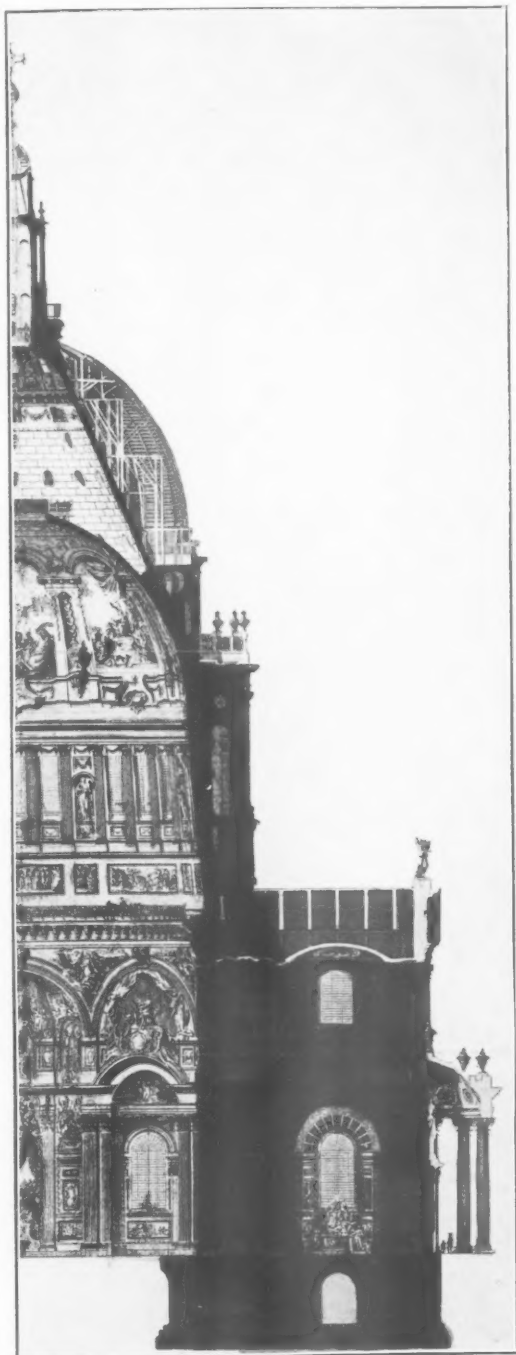
From these tests we are surely justified in believing that the towers themselves are perfectly sound and capable of doing all the work that is laid upon them; that the movements we can see to have taken place are all from below.

In view of the great precautions which Wren took, as has been shown, to ensure the steadiness of the great piers and to avoid the chances which he foresaw of a possible side slip, it is surely very unwise, if one may not indeed say reprehensible, to admit graves to be dug as they now are between the piers, and going down, as they must do, as low as if not even below the bottom of the footings. From the very nature of things the graves have to be dug in a hurry. Digging a hole and lining it with good brickwork surrounded by concrete—and that is always done—does not tend to increase the solidity of ground. In result, there are certain lumps of concrete dotted about here and there in the earth which lies between the footings of the piers and walls. The concrete is pinned up close against the footings except by chance, not in a continuous line of hard and solid material carried from pier to pier.

It is useless to point out an evil and not suggest a remedy.

The remedy now suggested is, selecting suitable places in the floor of the crypt, to build beforehand, in vitrified bricks and surrounded with cement concrete, a complete series of graves in a row extending from pier to pier or wall to wall. These firmly imbedded in concrete and pinned up against the footings would make a solid block and would certainly render the substructure of the Cathedral more solid than it ever has been.

SOMERS CLARKE.



THE SPREAD OF THE DOME SUPPORTS.

Books.

OLD HOUSES IN EDINBURGH.

Fifty-four Drawings by Bruce J. Home, reproduced in collotype with descriptive notes and introduction by Professor G. Baldwin Brown. 15½ in. x 11 in. 24s. William J. Hay, Publisher, Edinburgh.

AFTER forty years of patient work Mr. Home has completed his fine series of records of lost and perishing Edinburgh. It would be almost necessary to set up an *apparatus criticus*, such as is beloved by scholars, if one wished to examine in detail the many methods of draughtsmanship which Mr. Home has employed, for his touch varies greatly. There are, however, two outstanding characteristics: fidelity in detail, and a masterly handling of shadows. Outside these limits the drawings range from studies of the utmost brilliance, full of cold Northern sunshine, such as those of the interior of Brown's Court to the north, and the back of Bakehouse Close looking northward (both in the first series), to the other extreme of a flatness almost pallid, such as the picture of Hope House in the Cowgate.

Through all the drawings there is a feeling of pious attachment to the truth; if Mr. Howe sets down naught in malice, he at least extenuates nothing which a less honest pencil might ignore.

Much of old Edinburgh is frankly slum, and some of the drawings are quite brutally frank, as indeed they should be, for the collection is destined to be of real future antiquarian, as it is of present great artistic, value. One feels that Ruskin and Twopeny would have taken equal delight in the sound technique and the patience of it all, so far removed from the splashy or scratchy mannerisms which too often masquerade as clever draughtsmanship.

As to subjects, one is led through delightful byways of both local and national history, we renew acquaintance with that enchanting scoundrel Deacon Brodie, and are reminded by the pictures of Lady Stair's House, not only of the wonderful social achievements of that great Scots lady, but also of Lord Rosebery's recent generous gift of the house as restored to the City of Edinburgh. The notes prefacing each picture are interesting without being garrulous, and are printed in immense type which is a joy to read, and with colossal initial letters which add to the decorative character of the book. The introduction contributed by Professor Baldwin Brown very rightly draws attention to Mr. Bruce Home's "competent structural knowledge," and if one feels that the artist must sometimes have wearied of his own amazing accuracy, even if one has an occasional sense of the "bitty" (a vulgar word, but not unexpressive), there remains deep gratitude for the architectural feeling which permeates these wonderful records of a great historical city, now falling all too rapidly before the pick of the housebreaker.

The controversy as between draughtsmanship and photography is old and perhaps futile and needless, but many of the claims of the protagonists of the camera would fall flat, had all artists the inspired accuracy of Mr. Home.

John Knox's House, where Mr. Hay publishes the book, naturally figures in the series of drawings, and on paper, as in its native stone, is an abiding delight.

THE PEACE PALACE DESIGNS.

The Palace of Peace at The Hague. The 6 premiated and 40 other designs. In 8 Parts. Parts IV. and V. 10s. 6d. net, each.

WE have received Parts IV. and V. of the Reproductions of Designs in the Peace Palace Competition. These contain two of the designs sent from England, viz., those by Mr. Jan F. Groll, of London, and by Mr. J. Coates Carter, of Cardiff. Among the other designs published in these parts are those by Mr. Eduard Cuijpers, of Amsterdam, M. Felix Debat, of Paris, and Mr. E. Saarinen, of Helsingfors.

THE ART AND CRAFT OF GARDEN-MAKING.

The Art and Craft of Garden-making. By Thomas H. Mawson, Hon. A.R.I.B.A. Third Edition, Revised and Enlarged. Pages xx. 310. Illustrations 262. 13 in. x 10 in. 35s. London: B. T. Batsford.

IT is not often that a reviewer can give so hearty a welcome to a new edition as in the case of Mr. Mawson's book. Not only is the letterpress greatly increased, but the illustrations have leapt from 178 to 262, and their quality has greatly improved. Time is on the side of the garden architect, and Mr. Mawson is now able to reproduce photographs of gardens in being, which in earlier editions were not mature enough to show a proved success.

There are also three garden schemes now illustrated for the first time. "A Warwickshire Garden" is an excellent example of straightforward formal design, full of pleasant features, but unaffected. In "A West Country Garden" Mr. Mawson had the advantage of working in close relationship with Mr. Dan Gibson, who was the architect for the remodelling of the house, and the result is harmonious and interesting. The plan of the garden is markedly irregular, due to variations in levels and the large number of buildings set at all angles. Mr. Mawson has made great play with terraces and long flights of steps, and a thatched summer-house in a walled court is a very attractive feature.

The most notable accession to this edition is, however, the garden at The Hill, Hampstead, the residence of Mr. W. H. Lever, M.P. The work has been done very rapidly (Mr. Mawson seems to hint discreetly at an impatient client), but already the gardens begin to mature, and the photographs do not suggest that they are little more than a year old. The pergola is massive and spacious, and when the creepers have had time to spread, should be a miracle of greenery for a London suburb.

Amongst other gardens of which new photographs now appear are those of Foot's Cray Place and Wych Cross Place. A fine stone seat at the latter is happily reminiscent of the splendid example at Wilton.

Altogether, the increasing number of architects who attach great importance to garden design and equipment are thrown by this edition into deeper debt to Mr. Mawson, whose immense practical experience gives to his views a peculiar authority.

Mr. Batsford has produced the book in his usual lavish way. The big pictures by way of end-papers are a distinctly happy idea, and the cover design is a great improvement on the last edition. Where everything that makes such a book valuable is gathered together, criticism loses (and we wish it to lose) any sting, but one bone must here be picked with Mr. Mawson. If he would pay more attention to the literary side of book-making, the book would be greatly more readable. We have shed tears over infinitives remorselessly split, and over words which are caricatures, like "viewly." Here is a baffling sentence: "The demands of legislation impelled Mr. Lever to purchase and transform this mansion," &c. Our first impression was that a Utopian Government had passed an Act bidding Mr. Lever spend his princely fortune on making beautiful gardens. Doubtless Mr. Mawson means that Mr. Lever has to live somewhere in London in order to attend Parliament, and cannot live without a garden, but he hardly says so.

In the preface acknowledgments are made to Mr. C. E. Mallows and other *Misters* for their perspective views, &c.; while it is to Joseph Brown, *Esquire*, B.A., that thanks are given for "reading over my MS." This seems to the casual observer invidious, and we cannot congratulate the esquire in his character of literary sleuthhound.

But this is, of course, a detail, and we are really delighted with the book, which is a necessity for every architectural library.